DEPARTMENT OF PHILOSOPHY, LINGUISTICS AND THEORY OF SCIENCE

CORPUS EXPLORATION AND DIALOGUE SYSTEM DESIGN FOR A VIRTUAL LIBRARIAN

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Abstract

This thesis is a part of the virtual librarian project for the City Library Gothenburg (Stadsbibliotek Göteborg), which is a public city library. The objective of the project is to develop a virtual librarian using machine learning and AI approaches to replace the current webchat solution to reduce the workload of human librarians and increase satisfaction among the patrons.

This thesis offers a systematic approach for the development practice based on small existing corpora for small and middle-size institutions, in which resources, especially technical development resources, are limited.

The methods take the workload off from the side of the principal[1] significantly, using requirement analysis with a narrative interview; topic-session based annotation with expandable tag set without detailed annotation guidelines, which requires less linguistic pre-knowledge and training process; and intent identification through corpus analysis with the assignment of priorities. Furthermore, this thesis offers a classification of intents based on the patterns of system behavior, which simplifies the formation of a complete intent list.

Since Rasa is the preliminarily prioritized platform for the implementation of the virtual librarian, this thesis also engages a short competitive product analysis of the dialogue systems in the Rasa showcase. In the end, some technical suggestions for Rasa implementation are given, reflecting the requirements from the City Library Gothenburg.

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[1] A term often used in accounting: business owner or people who provide (economic) resources.

Statement of contribution

The work done in this thesis was done in a participation with a research group consisting of Linnea Strand, Robert Rhys Thomas, and Xiao Li, supervised by Simon Dobnik (GU); Mehdi Ghanimifard (GU); Magdalena Sandahl (Stadsbibliotek Göteborg).

The goal of the project is to develop language processing tools that would assist interaction of patrons in the Stadsbibliotek Göteborg.

The research questions and related work packages required to complete them described in this thesis were developed independently by the author with consultation with the supervisors.

The work depends on and has utilized the following work-packages developed in the project:

- Dataset collection and annotation which was completed by the team of the City Library Gothenburg.
- Data pre-processing which was completed by Robert Rhys Thomas.
- Some reflections on ethical issues from Magdalena Sandahl.

The work contributes with the following work-packages that are utilized in the research project:

- Profiled the requests for the virtual librarian using the method of interview.
- Provided a quantitative and qualitative analysis of the collected corpus, with the most relevant topics.
- Provided a method for categorization of the intents based on the behaviours of response of a dialogue system for further technical implementation.
- Carried out a competitive products analysis of some of the applications in Rasa show case.
- Gave some suggestions for the technical implementation in the Rasa environment.

Preface

"(For our patrons), it is more frustrating to get no answer than to get an unsatisfactory one."

-Magdalena Sandahl (Stadsbibliotek Göteborg)

"One way to prevent a conversation from being boring is to say the wrong thing."

-Frank Sheed

With the mentioned gist, I started to work on the virtual librarian project for Stadsbibliotek Göteborg. It has been personally an exciting journey at the end of my year in Gothenburg as an exchange student, and especially in the time, where the COVID19 hit the world severely.

As a computational linguist from Germany, I have experienced all kinds of quarrels about the ***ratio legis*** of engaging systems that may potentially replace inter-human communications. Very few of us have expected that the persistence was undermined all of a sudden silently by some infinitesimal enemies.

I would like to express my sincere appreciation for my supervisor Simon Dobnik, for his patience and academic guidance; my co-supervisor Mehdi Ghanimifard, for his insightful inputs, and my supervisor and contact person Magdalena Sandahl from Stadsbibliotek Göteborg, for our inspiring talks and many precious impressions into the library world.

The era that measures our social relationship by physical distances has been long gone!

Contents

1. Introduction

Language is the most precious jewel of humankind. Already from the myth of the tower of Babel (Brow, 1997), people consider the ability to speak what makes us human (Friederici, Skeide, & Müller, 2016). A wide range of linguistic researches have been therefore carried out, and many plead for the view that language is unique to humans (Fitch, 2011; Ghazanfar, 2008; Pagel, 2017; Saussure, 2011).

While the idea of building intelligent machines has been fascinating people for long, the discussion about defining intelligence has also never stopped. Yet there seems to be no depute that the ability to speak should belong to the fundamental ability inventory of an intelligent machine, as the most notable test for intelligent machines is designed initially with language as a medium (Gamez, 2018).

Dialogue systems have been brought to many everyday scenarios with increasing ubiquity. One of the most important motivations is to reduce the workload of human labor and increase efficiency. While the usage of dialogue systems has become a common practice in the industry, there are few projects in the field of the library. The pioneer projects such as "Bizzy" from University Library of Oklahoma (Young, 2019), UC Irvine (Kane, 2013) and Singapore Management University (Mohammad Ali, 2019), some of them are already in active use and able to answer low-level questions and carry out some preliminary functionalities.

1.1 The focus of the thesis

This thesis focuses on the explorative work on a chat corpus collected by City Library Gothenburg in daily operation between patrons and librarians, aims to work out a framework for the dialogue system design for a virtual librarian. This is the first attempt at the task. The data collection for this project started in January 2020 with the help of the City Library Gothenburg after consulting GDPR[2] and implementation of user's agreement on the webchat surface. Furthermore, the technical specifications of Rasa as the preliminarily preferred platform for project implementation are also analyzed and taken into consideration to support the future work of the project.

The project is specific in the following aspects:

a) The project is distinguished from other prototypical chatbots (such as all the above-mentioned) in a way that it is built from scratch and is based on a collected copurs.
b) The corpus is collected incrementally and limited in terms of size and quality. The time span of the data is relatively short (about 3 months), and this may lead to distributional unbalances.
c) There is no detailed technical project description for the chatbot design and system requirement, which is not a common practice in the industry.
d) The annotation work is carried out without pre-defined tag sets. The annotation is carried out by librarians following a dialogue-topic-based principle rather than utterance-intents-based principle.

In this thesis, both quantitative and qualitative methods will be engaged to profile the needs of the library. Also, this thesis is to support further research work of Linnea Strand and Robert Rhys Thomas, so that they can translate a part of their results symmetrically for the virtual librarian.

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[2] GDPR— General Data Protection Regulation (EU 2016/679 is a regulation in EU law on data protection and privacy in the European Union (EU) and the European Economic Area (EEA).

1.2 Contribution of the thesis

This thesis will provide:

a) A qualitative description of the chatbot using the method of an interview as meta-input for the chatbot design.
b) A quantitative description of the corpus and the distribution of patrons' requests. This will help with understanding the needs of patrons and prioritizing the tasks to be implemented.
c) A categorization of the intents systematically for system design.
d) Suggestions regarding technical specifications regarding Rasa and solutions for the implementation.

1.3 Outline

In chapter 2, the backgrounds of the development of dialogue systems in both computational and linguistic aspects will be introduced.

In chapter 3, the results of an interview with the supervisor from the City Library Gothenburg will be presented and interpreted as global requirement inputs for the system design.

In chapter 4, corpus analysis will be carried out engaging quantitative methods to identify the most important functionalities for the system design.

In chapter 5, the intents will be categorized systematically into four categories, and an explanation will be given how this categorization helps with the system development.

In chapter 6, the current common practice using Rasa as the technical solution in the industry will be investigated, and the applicability for virtual librarians will be evaluated.

In chapter 7, a competitive product analysis will be carried out for the dialog systems using Rasa and technical possibilities of Rasa will be examined, and some suggestions for system design will be given.

In chapter 8, I will take a look back at the thesis and have some reflection on the research journey and then draw some conclusions.

1.4 Terminology

According to Jurasfky and Martin (2019) conversational agents or dialogue systems are programs that communicate with users in natural language. They distinguish two classes of conversational agents: task-oriented dialogue agents (task-oriented) and chatbots (entertainment-oriented). The former is primarily used to help complete tasks such as make an appointment, give directions, find restaurants, or control other devices, while the latter is "by contrast, designed for extended conversation, set up to mimic the unstructured conversations or 'chats' characteristic of human-human interaction, mainly for entertainment, but also for practical purposes like making task-oriented agents more natural". In this thesis, the terms "dialogue system", "chatbot", and "virtual librarian" are used interchangeably. The objects of development — the virtual librarian is called "chatbot" in our discourse with the City Library Gothenburg, without being misleading.

Some abbreviations:

LDA — Latent Dirichlet Allocation

NLP — Natural language processing

NLU — Natural language understanding

2. Background of dialogue systems development

2.1 From the computational perspective

ELIZA is often referred to as one of the earliest conversational systems (Weizenbaum, 1966). ELIZA was built based on simple pre-defined rules. ELIZA played the role of a Rogerian psychologist by reflecting patients' statements back at them (Jurasky & Martin, 2019). This "psychologist" uses the strategy of having no real-world knowledge (and it has indeed no real-world knowledge at all) and motivating patients to express themselves.

From the 1970s, the GUS (Genial Understander System) dialogue systems (Bobrow at al., 1977) represents a form-based approach, which has influenced the industry for several decades. GUS systems have frame-based architectures, and this suits the demand of domain-dependent commercial applications such as travel booking, call center handling, etc. Jurafsky & Martin pointed out that "GUS architecture has been astonishingly long-lived and underlies most if not all modern commercial digital assistants". (Jurafsky & Martin, 2019, Chapter 26, p.12)"

In the 1990s, the statistical approach started to flourish in the field of natural language understanding and supported dialogue slot filling (Miller, Stallard, Bobrow, & Schwartz, 1996), which turned out to be an efficient strategy to fulfill users' complex requests.

Another powerful engine for the development of dialogue systems is the technical revolution of the Internet and the hardware. With personal computers turning more and more portable with increasing computational power, the environments in which dialogue systems are used have changed immensely. The rise of the web transformed the WWW into a gigantic corpus. Technologies such as information retrieval (IR) (Zhou, Gao, Li, & Shum, 2018) and machine learning (ML) (Ritter, Cherry, & Dolan, 2010) emerged and developed quickly.

With the pioneers of intelligent personal assistants such as Siri, Alexa, and Cortana, etc. delivered with smartphones, dialogues systems have been increasingly ubiquitous.

The state-of-the-art systems contain a series of modules: automatic speech recognition (ASR), natural language understanding (NLU), dialogue management, natural language generation (NLG), and text to speech (TTS). The performance of each component differs vastly. While there are already satisfactory solutions for ASR (Kim et al., 2019) and TTS, there is still room for improvement in NLU and dialogue policy. These are processes of machine comprehension of natural languages with high complexity and responding accordingly. Natural languages are less structured and not formally defined and the most important aspect of the challenges is ambiguity[3]. On the semantic level, the polarity, negations and anaphora[4] are still challenging topics for NLU. On the pragmatic level, the dialogue systems still have difficulties understanding irony and sarcasms and responding messages with non-understanding (failed to be understood) content. For the dialogue policy, it is hard to model language use in context and in interaction. At the current stage, a dialogue system needs a good knowledge of the domain, and also it need to handle conversational strategies, which makes classification, especially multi-intent classification challenging (Yang, Wang, & Wang, 2019) (Ritter, Cherry, & Dolan, 2010). Besides domain-based approaches, there are also some novel attempts to build dialogue systems. (Huang, Zhu, & Gao, 2019).

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[3] This also applies to most of the NPL tasks, Jurasky and Martin (2019) addresses this aspect in several chapters such as 6, 13, 25, 26.

[4] For example, in the expression "only good but also amazing", the negation word "not" here does not change the polarity but intensifies it. Some words such as ever, never, little etc. have a anaphoric linguistic nature, which makes the resolving of the senses challenging.

2.2 From the linguistic perspective

Arguably, if the ultimate goal of dialogue systems is to achieve the perfect analogy to human-human dialogue, then all the linguistic aspects of human dialogues become automatically crucially relevant for dialogue systems.

In order to arm dialogue systems with the ability to understand the meaning of the utterance is an essential step towards a "speaking machine". Semantics, as the study of meaning, is relevant for dialogue by its nature. Semantics is also a study with rich history which can be traced back to ancient time such as Plato and Aristotle's theories of meanings.

Systematic studies were first carried out in the frame of philosophy and logic. A hierarchy of studies are built up: **semiotics** is the science of signs (a series of studies by Charles Sanders Pierce) summarized by Yakin & Totu (2014), **syntax** as the science of how to compose the signs, **semantics** studies the denoting and the denotation of signs, and **pragmatics** as the science of the interaction between signs and their users.

In the 1940s, Carnap set up two poles of semiotics: pure and descriptive. In pure semiotics, the focus is on formal language and logical expressions, while descriptive semiotics is based on natural languages and empirical study (Uebel, 2013). Bar-Hillel united these two poles in the 1950s and stated the dichotomy of pragmatics (Margalit, 1990). There were other attempts to capture natural language meanings with formal languages such as Grice's maxims theory and Horn's scalar theory in the 1970s.

The foundational theory of conversation studies was set by Austin (1962), based on the idea of Wittgenstein (1953), that conversations are actions of speakers. Searle (1968) elaborated these concepts further into the theory of speech acts, which has been one of the essential contributions to modern communication science and pragmatics. Speech act theory successfully extracts the behavioral layer from the semantic surface of utterances. A speaker performs utterances with certain intentions, this makes the resolution of these intentions essential for dialogue systems.

The fact that dialogues are human actions opened a new angle of how to consider dialogues computationally: dialogues should, like other human actions, can be planed (Bruce, 1975). Dialogue systems should listen to the utterance and find information that helps with interpreting speech acts and turn it into the plan(s), which fall into the plan action inventory. The assumption is that the conversations are driven by human motives so that the key to tackling the difficulty of dialogue systems is to decode people's incentives.

Following this view, plan-based models of dialogue are built based on BDI (beliefs, desires, and intentions) (Bratman, 1987) between interlocutors. This model successfully included the understanding and knowledge of dialogue participants. Dialogues had become a dynamic process with interaction with encoding intentions, decoding desires, and updating beliefs.

In recent years, apart from the plan-based methods, there are some other approaches in dialogue management, for example the information state approach (Larsson, 2002), where the agent keeps an information state that is updated by dialogue rules as the conversation unfolds. This approach revealed the potential that issues (semantically modelled questions) can be used as a basis for dialogue management.

A similar approach is implemented in Smith et al. (2011) for free affective dialogue where and agent keeps an object store of entities and events which trigger dialogue actions or new utterances parsed by the NLU introduce new information to the object store.

Another integral theoretical part of human dialog studies is dialogues analytics, which includes all analytical studies on human dialogue, aiming to extract behavioral conversational strategies. Turn-taking (Gravano & Hirschberg, 2011), revision (Beißwenger, 2010), alignment (Garrod & Pickering, 2009), initiatives (Core, Moore, & Zinn, 2003), grounding (Larsson, 2018), feedback mechanisms (Purver, Hough, & Howes, 2018) are some of the objects of the studies.

2.3 Ethics: ethical issues in dialogue system design

People are becoming increasingly cautious about ethical issues in dialogue system design (Jurasky & Martin, 2019). Considering the human-system analogy as one of the essential goals of the success of dialogue systems, it is crucial to create agents that act within both general and specific legal and moral frames.

Data privacy is one of the most important concerns in dialogue system design. EU 2016/279, known as GDPR is a set of regulations that aims to protect personal data. However, due to the ubiquity and variety of user scenarios, dialogue agents may "hear" and "tell" private information without the user realizing it.

"The talk Barbie", that keeps children company and "talks" to them sounds like a horror movie to many people, however, it happened with dialogue system based "hello Barbie", said Akenzua (2019). The hello Barbie has aroused controversy, some even declare the end of the childhood with this WLAN functional talking doll However, this kind of application also has the potential to detect psychological problems in their early stages, help to reduce loneness. There are also ethical dilemmas such as if the company finds out that a child is abused by her/his parents, should it be reported? This kind of discussion will never end, but it is true, that the more dialogues systems integrate into our lives, the more cautious we have to be.

Bias and discrimination are two further aspects of ethical issues. To the question, how bias derives, there often tend to be a short answer: training data. However, the bias can creep in long before the data is collected (Hao, 2019). Some biases are inherent, which means these biases are caused by the initial system design and the purpose of the system. For example, a research question such as do facial appearances have relationships with sexual orientation – the infamous Stanford paper (Levin, 2017) or in our case, using languages and speech as the source of features. Another example is the Californian "police robot", which blacklists certain cars and group of people (Rohrlich, 2019). Very often, it is not enough, only to have a balance of utility and risks, there should be also some ethical bottom line, which is never allowed to be touched.

Furthermore, dialogue systems can be also abused. User may feel less restricted to social norms when they communicate with chatbots instead of humans. Microsoft's chatbot Tay went offline after less than 24 hours because it was taught to speak in a rude and racist way. This shows the weakness for AI and self-adapting learning processes without sufficient control. Dialogue system abuse has at least two levels[5], the first is to maliciously frequently call up the service so that the capacity of the service and system is exhausted so that the system is not available for other legit requests, the second is unexpected and not desirable system behaviors, if the chatbot works with mechanisms to learn from the interactions with users.

The European Commission published a white paper on artificial intelligence - A European approach to excellence and trust (European Commission, 2020), which addresses the key concerns about the development and application of AI in the modern society. EU called up seven "High-Level Expert

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[5] Based on the course Ethics for NLP held cooperatively at Technische Universität Darmstadt by Iryna Gurevych and Carnegie Mellon University by Yulia Tsvetkov, online accecable via: http://demo.clab.cs.cmu.edu/ethical_nlp/.

Groups" forming guidelines accordingly, and these seven key areas can be seen as the major challenges in the field of AI, which are also applicable for dialogue system design: Human agency and oversight, Technical robustness and safety, Privacy and data governance, Transparency, Diversity, non-discrimination and fairness, Societal and environmental wellbeing, and Accountability.

In this thesis, ethical concerns and professional judgment are addressed accordingly in chapter 2,3,4,6.

3. The interview

3.1 Before the interview: the current solution for online chat service

Initially, the City Library Gothenburg only provided a general project description of the existing IT network structure. The current webchat solution is linked to the LibraryH3lp application for human-human interaction. LibraryH3lp is an integrated instant messenger and web chat system designed specifically for Virtual Reference services in libraries (Sessoms & Sessoms, 2008). After being connected with a librarian, the requests from the patrons are carried out manually by the connected librarian and the results are sent back as chat responses. However, it is common for software development processes, that a detailed functional requirement description and technical framework are created and handed over to the developers. In the practice in the industry, this is done by the product managers by following a series of steps of IT development conventions, as translators between the principal and technicians.

Figure 1. A screen short of the current webchat solution, which connects the users differently with a human librarian and starts an ad-hoc dialogue session

3.2 The format and objectives of the interview

The interview consists of eleven questions. All the questions are formulated to not contain technical and academic terms in order to increase the understandability of the questions so that the interview can also be carried out with interviewees potentially with less technical expertise. The interview was carried out via online video chat and was planned to last no longer than 45 minutes.

The interview is an effective method for informatics system design with the advantage to directly understand the needs of the City Library Gothenburg with narrative information, which cannot be replaced by technical descriptions (Jones & Marsden, 2006). It is, therefore, meaningful to use the method of the interview to directly communicate with the City Library Gothenburg with questions designed to extract system requirements.

The interview was indented for a representative from the City Library Gothenburg, who should have overall knowledge about the library, experiences with patrons' relationships and at the same time, have an overview about the current information infrastructures of the library.

The interviewee I chose is Magdalena Sandahl, who is the product project manager at the City Library Gothenburg. She is a in-house librarian at the City Library Gothenburg with rich experiences and dedicated to digital solutions for the library domain.

3.3 The questions/topics of the interview

The questions (appendix I) targets to find the answers to the following:

a. The character of the chatbot, entertainment bot, or commercial bot.
b. How important is that the chatbot has human empathy.
c. Profiling the persona of the chatbot.
d. Some technical details: fallback policy, initiatives, failure handling, etc.
e. Existing knowledge pool for question answering.
f. Existing database.
g. Expectations of user reactions and shifts in user behaviors.

3.4 The answers to the questions

a. To the question, what is more important: that the chatbot acts like a human or gets the job done, the interviewee prioritized the human-like behaviours to the functionalities. This indicates that the dialogue system should be an entertainment chatbot according to Jurafsky's categorization rather than a commercial bot.
b. It is important for the interviewee that the chatbot should have human empathy and treat the user with a sense of humour in a Gothenburg way[6]. The value of the chatbot is to provide the patrons with new experience and, at the same time, reduce the workload of human librarians. At the current stage, the librarians work for chat-based patron service on a side-work basis. There is no guarantee for a response. According to the interviewee, this often leads to huge frustration. The chatbot is an ideal solution to increase the rate of response. Every request successfully handled by the chatbot releases the capacity of the librarians for more high-level unsolved questions.
c. The chatbot should present itself as a young chatbot for the City Library Gothenburg who is curious, witty, polite, willing-to-help, down-to-earth, and local, who likes to surprise the users with some "extras".
d. The systems should greet the users at the beginning of the session. After the introduction, the dialogue should have mixed initiatives. The users can ask questions, and the chatbot should also be able to lead the dialogue flow in certain situations.
    The system should tolerate failures. According to the interviewee, this may encourage the users to explore the system. Failure allowance in terms of times of repetition can be set to five. It is important that the system can give guidance to direct the users to reformulate themselves in favour of task performance.

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[6] My level of Swedish language stayed after intensive course intensively bad. I looked up in the internet, what is so unique about the Gothenburg humor. According to the webseit StudyinSweden,se (Usisipho, 2018) : "Gothenburg is (in)famous for its special brand of humor. Here, this is the pretty much the local equivalent of a dad joke. You know, the kind of jokes that are so cheesy, that they're actually good. The jokes are often based around Swedish puns and plays on words, so it is often quite difficult or even impossible to translate these jokes to English."

e. There is currently no existing knowledge pool for frequently asked questions. The responses of the librarians are human knowledge-based. There is a preliminary attempt to create pre-formatted greeting template with the help of Library H3lp.

f. The physical media which include books, magazines, CD, DVDs, etc. are collected and organized by the Gotlib catalogue. The API allows customized queries. Besides the search query, other functionalities, such as reserved items, are manually executed by the librarian using Sierra[7]. The library does not have admin control over other existing sources such as Cineasterna for movies and uTalk for language courses, which means the librarians have the same access level as the users. Usually, the sources are recommended by the librarian to the user and there are no further higher-level requests such as change the due date, change or reset PIN etc, to be executed.

g. The interviewee emphasized that no functions requiring personal data should be implemented, such as reservation of media using library card number. This is, on the one hand, due to the wish to comply with GDPR and, on the other hand, due to the trend that the user should be educated to get used to guided self-service. The interviewee expects an increase in traffic and more explorative actions. Regarding system abuse and abusive language, there is a certain possibility; however, based on experience with patrons and considering the target group this is not probable.

3.5 Ethics: Concerns about system abuse

The ethical concerns are primarily embedded in the last question about the system abuse. In terms of user traffic, the system should allow, to some extent, explorative purposes, which reflect the requirement of the chatbot's entertaining characters. The City Library Gothenburg considers the introduction of virtual librarian as one of the symbols of their digitalization processes and the interviewee believes that the digitalization will lead to increasing user traffic. In the interview, the interviewee addressed considerations about the strategy against spamming and unauthorized access.

Regarding abusive language the interviewee estimates relatively low risks. Based on her experiences, the most patrons are polite and patient even in case of conflicts, it can be resolved at the end, and especially in this certain domain, patrons will still stay polite.

In more advanced stage, the virtual librarian will be trained based on real dialogue data, the quality of data should be checked before use. Some efficient measures should be firstly taken such as "bad-word-lists" and it should be analyzed, why and in which kind of situations those words are used.

3.6 Conclusion

The interview achieved the set of objectives to a large extent. The chatbot should be an entertainment bot with human character: curious, polite, and witty in a Gothenburg way. The system should have a high grade of openness and allow explorative actions. The system should be failure-tolerant and allow mixed initiative dialogue.

The chatbot should be able to carry out search queries applying the Gotlib catalogue, and other functionalities that require personal identification should not be offered, instead of, understandable

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[7] Sierra is a set of APIs which offers solutions for digital library operation such as administration, circulation, cataloging, e-recourses management and acquisition. Available via: https://techdocs.iii.com/sierraapi/Content/zReference/introduction.htm

instructions should be given, so that the user can navigate and execute operations such as login, logout, postponing the due date etc., by themselves..

The challenge for chatbot development is the lack of an existing knowledge pool. A direct transformation and conversion from available knowledge into an answer database are not possible. It is then crucial to identify the most frequently asked question and organize the answers accordingly. Mechanisms have to be designed for the library to run and update the knowledge database in further daily operations.

4. The corpus

The preparation for corpus collection started at the end of 2019, and the data used here is up to date to till the end of March. In total, 740 dialogues could be saved from the communication between patrons and librarians.

The conversations between the patrons and the librarians in the corpus are updated incrementally and annotated by the librarian team and downloaded and processed by Robert Rhys Thomas.

Due to our goal that the dialogue system should assist the librarians, some interaction would be modelled by dialogue rules, but the rests ones will be sent to a librarian depending on the detected topic. To manage the interactions more efficiently, the tags used during annotation work are not assigned on a sentence-intent basis, but a session-topic basis. That means each conversation is considered as a session and tagged with relevant topics. The tag set is not pre-defined and can be expanded if annotators considers it necessary. An additional advantage brought by the topic-session based annotation is that it requires less linguistic knowledge and shorter training process.

4.1 Meso-structural observations

Wilson and Wilson (2005) define turns as speech exchanges between two or more parties where there is no external imposition of changing the procession on the flow of talk. If applied to the library chat corpus, it can be assumed that there is little or no external imposition during the conversation, and the chats took place exclusively between two interlocuters. This allows the simplification where a turn can be counted for each role change. In this thesis, each utterance with a different role from the previous one contributes 0.5 turns so that it is allowed to have an uncomplete turn to better reflect the length of the dialogues.

Table 1 shows the above-stated calculation, an average length of all the dialogue sessions is 2.85 turns. This reported length includes the automatically generated opening line: Hi, what can I help you with? And partially dialogue closing lines such as: "bye" and "take care", if the participants kept their presence until the end of the conversation.

Length	1.5	2.5	1.0	3.5	3.0	2.0	4.5	5.5	5.0	6.5
Frequency	260	90	74	72	44	43	41	21	17	17

Table 1. The ten most frequent length of dialogues in turns

Figures 2 shows an accumulated plot of the frequencies of the lengths of the dialogues. Among the 740 dialogue sessions, the most frequent lengths of the dialogues are 1.5 and 2.5 turns, followed by 1.0 turn. The coverage of the dialogues with the showing turns adds up first quickly at first. It can be observed that the dialogues with the 10 most frequent occurring lengths count up nearly 700 out of the 740 collect sessions in the corpus.
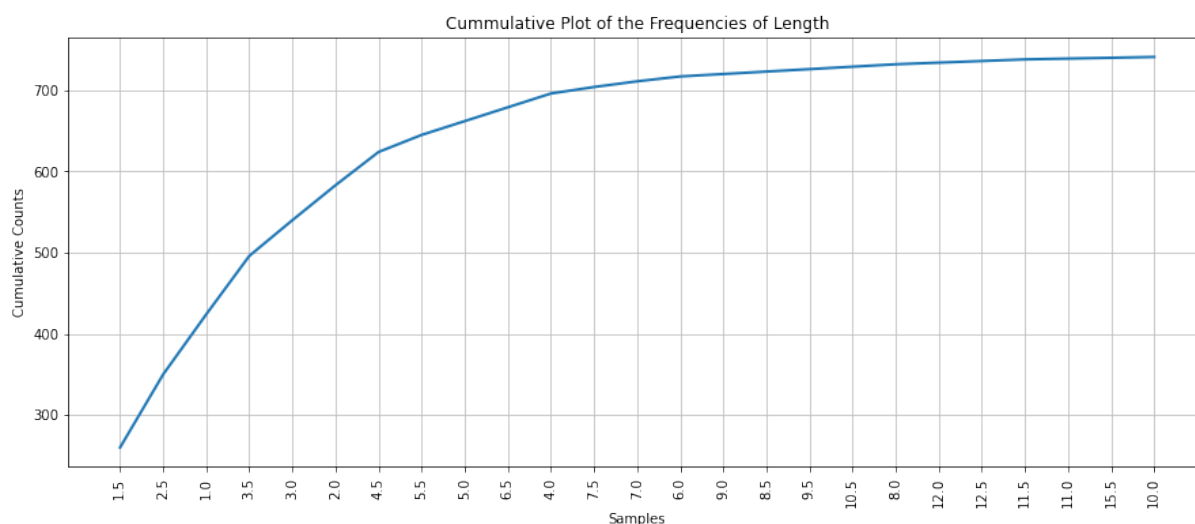
Figure 2. Cumulative plot of the frequencies of the session in turns

It is striking that a high percentage (16%) of all the sessions were interrupted and carry the tag "avbruten chatt (split chat)". After a closer examination, this is often due to a not timely response from the librarians. The following chat is one of the examples of non-response from the librarian and demonstrates the frustration of the user:

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_____
<librarian> hej! vad behöver du hjälp med?[8]
<user> hej !
<user> hej
<user> hej.
<librarian> hej! hur kan jag hjälpa dig?

<TAG> avbruten chatt (split chat)
_____
```

This confirms the knowledge gained from the interview, that to increase the response rate (or to decrease response time) is an important target for service improvement.

In general, it can be observed that the overall length of the dialogues is rather short. The users are question oriented and only turn to the chat service with a concrete question or a request. After getting the information needed, the users will wrap up the conversation quickly. This is an essential hint for the dialogue system design that it should be answer-seeking oriented, and the length of the conversations should be kept short. This tendency stands partially in conflict with the requirement extracted from the interview that the chatbot should primarily have entertaining character.

4.2 The individual tags and their distribution

In order to identify and analyze the intents, it is necessary to break down the tags to look at their distribution.

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[8] Unfortunately, time stamps are not available in the processed data given for the research.

The analysis is carried out with python and NLTK library (an alphabetically ordered tag dictionary see: Appendices II). There are, in total, 34 tags assigned 957 times in total. Each session contains, on average, 1.3 topics. This indicates that the topics of each session tend to have relatively low complexity.

The following is a sorted list of the created topics dictionary with absolute frequencies of the topics, that are determined and assigned by the annotating librarians, (a list of the tags and their descriptions and examples from the corpus can be found in Appendix II):

Rank	Tag	Frequency
1	avbruten chatt (split chat)	118
2	app PressReader	114
3	bok- & ämnessökning (book & subject search)	92
4	app Libby / Overdrive	74
5	reservationer (holds)	72
6	lån, omlån & återlämning (check out, extend loan & check in)	58
7	åsikter, förslag & frågor (opinions, suggestions & questions)	57
8	bibliotekskort & PIN-kod (library card & PIN)	51
9	No Tag	31
10	app 'Biblioteket'	28
11	gotlib katalogsida (Gotlib catalogue)	26
12	admin	22
13	inköpsförslag (purchase request)	17
14	förseningsavgifter, krav & inkasso (overdue fines)	15
15	ljudböcker, CD & mp3 (audiobooks)	15
16	låneregler (borrowing rules)	14
17	grupprum (group rooms)	14
18	biblioteksregler (library rules)	14
19	cineasterna & DVD film	13
20	fjärrlån (inter-library loan)	13
21	kontakt med biblioteken (contact with libraries)	11
22	öppettider (opening hours)	11
23	programpunkter & kalendarium (library events & calendar)	11
24	spam	11
25	fysisk utrustning & verktyg (tools)	9
26	chatt på andra språk (chat in other languages)	9
27	netloan datorer (Netloan computers)	8
28	TV-spel (video games)	6
29	app Legimus & talbok	6
30	borttappade media (lost library items)	6
31	databases	5
32	adress (address)	3
33	meröppet (extended opening hours)	2
34	naxos	1

Table 2. Table of annotated topics with their absolute frequencies

It can be observed through the figures in table 2, that the 10 most frequent tags cover already nearly 700 out of 957 times that the tags were assigned. If we take the most frequent "split chat" tag and the ninth most frequent tag "No Tag" out of consideration, the first eight most frequent tags can cover over 80% of all the topics. This can be used as a basis for the prioritizing of functionality of the dialogue system.

According to the request from the City Library Gothenburg, the only catalog-based function should be "search", which becomes the only function involving advanced search query from an external database. The other topics are the starting points for building knowledge maps. Questions are most often asked about applications such as PressReader, Libby, etc. Furthermore, some administrative information such as opening time and lending rules are also frequently requested.

4.3 Clustering

The clustering distribution of annotated tags can also provide us with valuable information on how the multiple requests from the users are composed together. Among the 740 sessions, 553 dialogues contain a single topic, 162 sessions contain two topics, and only 45 sessions contain more than two topics.

The following is a list of 10 most frequent co-occurring topics:

Rank	Bi-Topic-Cluster	frequency
1	('bok- & ämnessökning (book & subject search)', 'reservationer (holds)')	16
2	('avbruten chatt (split chat)', 'reservationer (holds)')	7
3	('bok- & ämnessökning (book & subject search)', 'gotlib katalogsida (Gotlib catalogue)')	7
4	('app Libby / Overdrive', 'bibliotekskort & PIN-kod (library card & PIN)')	7
5	('bibliotekskort & PIN-kod (library card & PIN)', 'reservationer (holds)')	7
6	('avbruten chatt (split chat)', 'lån, omlån & återlämning (check out, extend loan & check in)')	6
7	('åsikter, förslag & frågor (opinions, suggestions & questions)', 'avbruten chatt (split chat)')	5
8	("app 'Biblioteket'", 'bok- & ämnessökning (book & subject search)')	5
9	('gotlib katalogsida (Gotlib catalogue)', 'reservationer (holds)')	5
10	('åsikter, förslag & frågor (opinions, suggestions & questions)', 'lån, omlån & återlämning (check out, extend loan & check in)')	4

Table 3. The 10 most frequent bi-topic-clusters

Despite the fact that rank 2 and 7 contain broken chat flow, it can be observed that all the clustered topics include at least one "executive request" such as search, reserve a book, extend the loan and check out, etc. This shows a tendency that users tend to turn to the librarian when they have concrete requests. Although only a fraction of all the requests are able to be carried out by the human librarian, in most of the cases instructions are given by the librarians instead of carrying out the request for the users. It should still be reconsidered on how to improve the user experience by enabling the system with these core functionalities.

Although we have clearly defined the range of the functional implementation, that only the search function should be implemented, and all other functions should be handled with proper responses based on pre-formulated instructions. However, the City Library Gothenburg can still consider realizing other functionalities at a later stage.

An advantage of the dialogue system is its anonymity, which means the functions which cannot be carried out by a human librarian because of the GDPR, for example, a human librarian should never be allowed to ask for a user's PIN, are possible with a dialogue system by introducing secured input box integrated with the graphical user interface or some assuring utterances like "I promise not to remember any of your personal data after you leave the chat. All the data is securely encoded."

Figure 3. Screenshots of Bilibili App login screen Android 2.4.2. A neat GUI design

4.4 Annotation validation and further explorative work using LDA topic modeling

Word-based topic modeling is an established tool for clustering text documents. Topic models are Bayesian statistical models for unstructured data that can extract the underlying latent themes, and these themes are called topics, if the models are applied to textual data. Latent Dirichlet Allocation (LDA) is an unsupervised generative statistical method for modeling the corpus (Blei, Ng, & Jordan, 2003).

Since LDA is an unsupervised approach, it has the advantage that there is no annotation required as prerequisite so that the process is to some extent less affected by biases. However, there are also some unsolved problems in using this approach, such as instability and lack of criteria for selecting the model parameters (Koltcov, Ignatenko, & Koltsova, 2019). In linguistic research practice, this is often a trial and error process starting from research conventions.

In this thesis, the application of the LDA model has two main purposes: 1) exploration of new, previously undetected topics; 2) validation of the finding from the distributional analysis in the previous section. Due to the specific decision process for tag set and relatively subjective annotation practice, worries can be justified that there are potential topics that are relevant yet undetected, and also the prioritization solely based on frequency distribution can lack of validity.

Zhao et al. (2015) indicate that the performance of the LDA method has a fast decreasing trend when topic number moves in the range of (0, 30], and a local optimum can be reached at around 20. The corpus collected in this paper is specifically limited, especially in terms of size. The total corpus size is rather small, and the single file (a dialogue session) is as mentioned in chapter 4.1, also short. I restricted the topic number to 10 and 15 in two experiments with every single topic yielding 20 words. This is a realistic range to discuss together with the domain expert and the interpretation work can be finished in one online consulting session of discussion.

From the model containing 10 topics, the domain expert could identify five library-related topics: PIN-Code issue, library card related issue; Press Reader, newspaper; Inter-Library-Loan, and state of the lending. Other clusters can either not be assigned with topics or the topics are not related to library operation. (The yielded results see Appendices III).

From the model containing 15-topics, the domain expert could only identify four library-related topics: Downloading audiobooks, returning books, PIN-Code issue, and log in; PressReader, newspaper. (The yielded results see Appendices III).

Interestingly, in the results of both models, especially among the results of the 15-topic model, some clusters are identified as words that are not related to the library operation. Both experiments have

16

yielded topics with a cluster consisting primarily of English words. Topic 6 in 10-topic-experiment and topic 7 in 15-topic-experiment. In the 15-topic-experiment, the domain expert could interpret a group of "positive and polite words" (topic 4) and a cluster of "verbs" (topic 10).

The general impression of the domain expert is that the topics are not salient enough. However, some of the important aspects of patrons' needs can be reflected. Nearly all the extracted topics are covered by the tag set, and some of the topics with higher frequency such as PressReader were also highlighted.

4.5 Ethics: data integrity and security

Regarding data integrity, before the data collection, the City Library Gothenburg has thoroughly consulted GDPR, and the storage of the data is with explicit notification and agreement of the patrons by using the library chat service and starting a chat session.

The data is exclusively used for research and development purposes and is not shared with any third party. The storage of the data (GitHub, google docs) is private, with controllable access only granted for the development team and supervisors. Throughout this thesis, no personal data or data, which may reveal the identity of any person, is used. This has been achieved by applying an anonymization script that was run by the library staff.

Rasa is a set of tools, which can be run locally, no remote server is engaged for hosting and execution purposes of any Rasa component. This is of high relevance for data security, a locally runnable solution can assure the data security according to the principle of segregation. "locally" means no needs to connect to any server provided by Rasa.

4.6 Conclusion

The corpus provided valuable insights into the needs of the library users despite the limitation in terms of the size and quality. The design of the dialogue system became clearer after the corpus analysis by having identified, validated and exhausted the relevant topics through frequency analysis and topic modelling.

The sessions tend to be short and intent oriented. A list of prioritized functionalities/topics (Table 2) can be identified. Due to the requirements of the City Library Gothenburg, only catalog search as a function with interaction with the external database should be implemented; this leads to a further task package that a knowledge pool (an organized knowledge network for all potentially relevant information for the patrons) has to be established with cooperation with the librarian team.

Through the corpus analysis, the higher-level requests besides the search function also have relatively high frequency and the clustering analysis also shows the tendency that users tend to turn to the chat service when they concrete and often higher-level requests, which cannot be handled by question-answering. To ignore the implementation of these functions such as extend the loan, login, PIN services will affect the utility of the dialogue system, since some of the requests will not be satisfied. The suggestion for the City Library Gothenburg is to consider implementing further higher-level requests using the dialogue system, which would, according to the results of corpus analysis, profoundly improve the user experience.

5. The categorization

5.1 Intents and dialogue system design

Most of the dialogue systems currently used in the industry are based on user intents. Intent is a user's goal of the current utterance in a dialogue session. (Shi et al., 2019)

This is a logical choice because to help a customer, the intention of the customer needs to be classified (Howard & Cambria, 2013). The theoretical foundation of this approach can be traced back to Searle's speech act theory, which introduced speech acts as the atomic unit of linguistic communication (Searle, J. R., 1969). (Traum, 2000) answers the central questions for dialogue systems design based on speech act taxonomies, while Allen and Core, (2007) have developed the most popular scheme DAMSL for speech act annotation with a novel aspect which contains forward-looking (e.g. statement and info-request) and backward-looking functions (e.g. agreement and understanding).

Most commercial chatbots are designed in line with user intents taxonomy. Jurafsky and Martin (2019) sketched a commonly applied dialogue system design procedure — user-cantered design, which was put up by Gould & Lewis (1985), starting with a study the user and tasks by interviewing users and investigating similar systems.

Rasa (Bocklisch, Faulkner, Pawlowski, & Nichol, 2017) is an intent-based platform where intent recognition is an integral part of "Rasa Core", which is the dialogue manager module of Rasa. Rasa has developed different strategies for different types of intents, for example, direct short-cut replies for pre-formulated answers, buttons on the graphical user interface and input box solutions for user input, the customized search query for API (Application Programming Interface), etc. It is, therefore, meaningful to identify the intents and categorize them into groups so that different strategies can be applied to them. The intents in Rasa are loosely defined: intents do not strictly correspond to the speech-act taxonomy. However, all user utterances have to be assigned intents so that Rasa can choose responses properly.

Many of the guidebooks for the dialogue systems focus on technical implementations. A detailed analysis often comes after prototype completion, for example, using the Wizard-of-Oz method (Fraser & Gilbert, 1991).

Michaud (2018) presents a categorization after evaluating real customers' requests to a high-end hotel virtual agent "Edward" using SMS and twitter to communicate with hotel guests and draws conclusions for the design of a new chatbot from early interactions with users. The corpus is similar to the City Library Gothenburg corpus both quantitively and qualitatively. The corpus contains only 1023 texts (dialogue sessions) from 491 accounts over a period of 53 days. The attempt is to design a dialogue system assisted agent based on the existing real-world communication.

Her categorization has two dimensions: 1) dialogue acts taxonomy and 2) the distribution of tasks between dialogue system and human assistants.

In terms of 1), she distinguishes differences between questions, requests, and dialogues (see figure 5). This categorization is motivated by the fact that "they (the categories) represent abstractions from specific intents in which distinctions are made based on how the system will respond". However, this categorization is, to some extent, problematic because it does not ideally reflect the way how a system should handle the request, especially under the column "dialog" for example:

FAQ and Info should have similar response behavior[9]:

---

[9] The following are simplified demonstrations of system behaviors, the verbs in capital letters are the actions carried out by the dialogue system. These actions follow the order shown with "->".

ASK a question -> SEARCH in knowledge pool -> RETURN an answer;

Opinion intents should have been handled differently from other dialogical intents in a way somewhat like:

GIVE an opinion -> SAVE/SEND the opinion and (SEARCH for response/apology) -> RETURN message;

Furthermore, under the column questions, Highly Personalized Question and Contextual Question should have similar behaviors as action request:

ASK question/ GIVE a request -> INDENTIFICATE person and CHECK credential -> EXECUTE task -> TRACK task status ->RETURN message
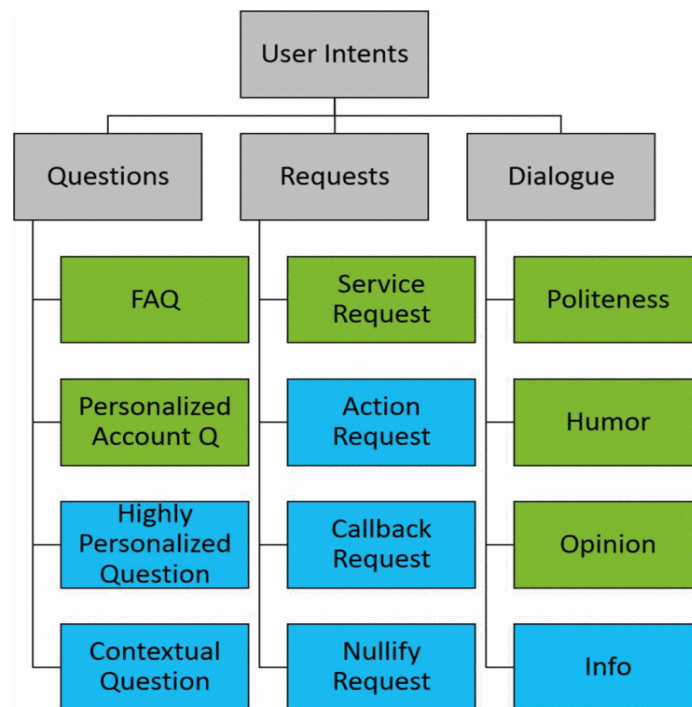
Figure 3. A two-dimensional intent categorization based on a small hotel chain corpus according to Michaud, 2018

In terms of 2), Michaud evaluated the technical possibilities and drew a line between the intents that should be handled by a human (marked in blue) and those that should be handled by a dialogue system (marked in green). The boundary between human tasks and machine tasks has become increasingly vague. While politeness intents which also include, according to her categorization, simple greetings can be handled by dialogue system, other intents such as humor can be challenging for dialogue systems (Dybala, Ptaszynski, Rzepka, & Araki, 2009). And when it comes to highly personal questions, the dialogue system has even, as stated above, the advantage of being anonymous and less sensitive to personal data.

Overall, Michaud's categorization seems to be arbitrary and may not be applicable for the virtual librarian project.

5.2 The four categories

In this thesis, the classification of intents is based on the intent handling strategies which are not only technically specific to Rasa. The categorization is only one-dimensional (without the aspect of technical accountability between human and dialogue system as stated in 5.1) because the chatbot design follows the principle "chatbot first and human librarian when the chatbot cannot proceed further." Similarly, the humor and the contextual questions are aimed to be handled by the chatbot first and then handled by a human. There are in total of four categories:

5.2.1 Dialogical

All the intents that primarily contribute to the macro-structure and those dialogues do not belong to functional, informational, and emphatical intents.

Dialogical intents can be handled by the dialogue manager and dialogue policy of the system without further interactions with external components. For example,[10]:

INTENT_GREET:

- Hi!
- Hallo
- Hej!

INTENT_BYE:

- Ciao
- Bye!
- See you soon

INTENT_CONTINUE:

- Wait a minute!
- I've got another question.

5.2.2 Informational

The intents that inevitably requires a piece of user-expected information as a return.

Typically, the FAQ belongs to informational intents or intents such as to ask for the time are informational intents. Informational intents can only be carried out with the help of a knowledge pool. The knowledge pool can be internally built, such as answer lists for the most frequently asked questions or external, such as a database with stored knowledge. It is notable that an informational intent always leads to a return of information, which is not dialogical[11]. For example:

INTENT ASK_FOR_OPENING_TIME:

- When do you open?

---

[10] These examples are not contained in the corpus, they are created for demonstrative purposes. Dialogical intents are essential for the dialogue flow and "hold" the dialogue together, however, they are not handled by a session-topic based annotation approach.

[11] The user-expected information motioned above is specific rather than general (it should be exactly the information expected by the user, not any other unrelated information). According to the definition, the examples showed below are mainly for information request rather than contribution to the macro-structure of the dialogues.

- Are you open on Saturday?

INTENT ASK_FOR_TIME:

- By the way, what's the time?

5.2.3 Functional

The intents that interact with the external world and lead to changes in the external world.

Functional intents can be seen as derivatives according to Searle's speech act theory (to use illocutionary force to change the outside world). The functional intents always lead to a change in the external world. External is meant in contrast to the dialogue system itself. For example:

INTENT_ASK_FOR_PROLONG:

- Could you please add 30 days to my deadline?

The change is to PROLONG the date in the library lending database.

INTENT_COMPLAIN:

- I am not satisfied with the services of XXX on X.XX.2020, I was …, then…, at the end…

Similar to suggestion, this will lead to the change to SAVE the complaint or suggestion text in a certain format in the backend dataset, which can be further processed by the quality control or the patron's relationship team.

5.2.4 Empathetical

Empathetical are the intents that contain emotions and are handled contextually. Due to technical restrictions, the empathetic abilities can be implemented at two levels: first, the ability to sense and to react to intents containing emotions and second, the ability to situationally react to users based on sensed emotions.

The main difference between empathetic abilities and dialogical abilities lies in situational ability. The system response should be situational, based on the sensed emotions rather than pre-formatted template response based on detected pattern of text. The current solution of most existing dialogue systems is partially breaking down the emotions to happy, sad, angry, this one-intent-for-each-emotion approach is also applied by Rasa.

Another possibility is to add an emotional, humorous layer to the dialogue system, for example as in case of the grumpy and paranoid "PARRY" (Colby, 1975) or Smith et al 2011.

INTENT_GREATFUL:

- Thanks, you are the best!
- That was a huge favour of you, I appreciate it, mate.

INTENT_UPSET:

- Stop letting me try again! I want to speak to a REAL librarian!
- You are stupid!

5.2.5 Multi-applicability of the categories

It is to be noticed that utterances may be classified for more than one category of intent. This is due to the complexity of the nature of the intents, and the multi-applicability does not stand in conflict with the usefulness for the dialogue design. On the contrary, the category combination provides valuable hints for the combination of response strategies for dialogue systems. In many of the dialogue system platforms, at least in Rasa, the response strategies are not mutually exclusive; the flexibility regarding customizable response is the strength of Rasa. For example:

INTENT_ASK_FOR_LENDING_STATUS:

- How long can I still keep the book xxx?
- Is my book xxx overdue?

This intent is informational since the lending status is requested and returned from the system, and it is also functional because the system can only send the query if the credential is checked and approved. This will change the status of the login status of the account at the backend.

5.3 Results of applying the categories on the existing tags

The following are the results of applying the above-stated categorization on our dataset. It is to be noticed that the categorization takes the demand from the City Library Gothenburg into consideration; some functional intents are only categorized as informational since the functions are explicitly not intended to be implemented.

	Intent	Dialogical	Functional	Informational	Empathetical
1	admin	-	-	-	-
2	adress (address)	-	-	x	-
3	app 'Biblioteket'	-	-	x	-
4	app Legimus & talbok	-	-	x	-
5	app Libby / Overdrive	-	-	x	-
6	app PressReader	-	-	x	-
7	åsikter, förslag & frågor (opinions, suggestions & questions)	-	x	-	-
8	avbruten chatt (split chat)	-	-	-	-
9	bibliotekskort & PIN-kod (library card & PIN)	-	-	x	-
10	biblioteksregler (library rules)	-	-	x	-
11	bok- & ämnessökning (book & subject search)	-	x	x	-
12	borttappade media (lost library items)	-	-	x	-
13	chatt på andra språk (chat in other languages)	-	x	-	-
14	cineasterna & DVD film	-	-	x	-
15	databases	-	-	x	-
16	fjärrlån (inter-library loan)	-	*	x	-
17	förseningsavgifter, krav & inkasso (overdue fines)	-	-	x	-

18	fysisk utrustning & verktyg (tools)	-	-	x	-
19	gotlib katalogsida (Gotlib catalogue)	-	-	x	-
20	grupprum (group rooms)	-	*	x	-
21	inköpsförslag (purchase request)	-	*	x	-
22	kontakt med biblioteken (contact with libraries)	-	-	*	-
23	lån, omlån & återlämning (check out, extend loan & check in)	-	*	x	-
24	låneregler (borrowing rules)	-	-	x	-
25	ljudböcker, CD & mp3 (audiobooks)	-	-	x	-
26	meröppet (extended opening hours)	-	-	x	-
27	naxos	-	-	x	-
28	netloan datorer (Netloan computers)	-	-	x	-
29	No Tag	-	-	-	-
30	öppettider (opening hours)	-	-	x	-
31	programpunkter & kalendarium (library events & calendar)	-	-	x	-
32	reservationer (holds)	-	*	x	-
33	spam	-	-	-	-
34	TV-spel (video games)	-	-	x	-

Table 4. Categorization of annotated topics. "x" for applicable, "-" for not applicable, "*" for applicable but not to be implemented in the current stage

5.4 Adding, splitting, merging and removing

In the above list of intents, there are no intents that are dialogical or empathetic. After examination of the corpus, there are mainly two reasons for the lack of these categories. The first reason lies in the annotation work. The topic-oriented annotation work does not reflect all the intents, for example those intents that operate on a meta-language level, which leads to a lack of, for example, *INTENT_GREET*, and *INTENT_BYE*, which are essential for the implementation in Rasa environment. The second reason is the special discourse environment: service requests are handled by real librarians through webchat solution in the library domain. The intents such as *INTENT_HAPPY*, *INTENT_UPSET*, etc. are absent in the corpus.

For the sake of the completeness of the dialogue system and to fulfill the development goal set by the City Library Gothenburg, some of the necessary dialogical intents and optional empathetical intents are added to the intent list. Additionally, for a demonstration purpose of the interaction with a non-database function, *INTENT_AKS_FOR_TIME* is also added.

	Intent	Dialogical	Functional	Informational	Empathetical
35	greet	x	-	-	-
36	bye	x	-	-	-
37	continue	x	-	-	-
38	happy	-	-		x
39	sad	-	-	-	x
40	upset (angry)	-	-	.	x

23

41	grateful	-	-	-	x
42	ask for time	-	-	x	-

Table 5. A list of added intents

Another draw-back of the topic-oriented annotation is that the tags sometimes do not deal with atomic intents. This requires further analysis and separation of intents, since the dialogue systems built with Rasa are designed to handle better simple intents. In this case, the intent 7: åsikter, förslag & frågor (opinions, suggestions & questions) is split into "opinions" and "further questions", intent 23: lån, omlån & återlämning (check out, extend loan & check in) is split into check-in, check-out, and extended loan.

In some cases, it can be meaningful to merge some topics together to reduce the redundancy of the system and increase the efficiency of the development. Attention should be paid to the intents that have the same or similar behaviors and therefore the same categorization. For example, if there were "book & subject search" and "cd & subject search", and "journal & subject search," and these requests are processed by the same catalog, the only difference is the format of medium. It would be desirable to merge them together and handle the three intents as one superclass "media & search". The specification of media format can then be implemented within the class. However, since the only functional and informational intent in our corpus is intent 11, and no other functional intent should be implemented, no meaningful merging operation can be found.

Finally, following this analysis it can be recommended that the intents are cleaned up, invalid tags, which cannot be used as intents should be removed. The characteristic of invalid tags is that they contain invalid categories, which are actually neither topics nor intents (1 admin: internal dialogues between the librarians; 8: split chat; 33: spam).

5.5 Conclusion

The final intent list can then be created by re-assigning meaningful intent names for dialogue system development and sorting the intents by priority, considering both qualitative and quantitative results from chapter 3 and chapter 4 (split intents are added according to the rank of the combined intent). The intents from number 1 to 8 are additionally added intents. Among these intents, number 1 to 4 are dialogical, 5-7 are on the first emphatical level and number 8 is an example for an both informational and functional intent. The further intents are ordered by the topic frequency reached in 4.2. This final intent list can be used as the development roadmap for the dialogue system.

Nr.	INTENT
1	GREET
2	BYE
3	CONTINUE
4	HAPPY
5	SAD
6	ANGRY
7	GRATEFUL
8	ASK_TIME
9	APP_PRESSREADER
10	MEDIA_SEARCH
11	LIBBY
12	RESERVE
13	CHECKOUT
14	CHECKIN

15	EXTENTION
16	PIN
17	OPINION
18	OPEN_QUESTION
19	APP_BIB
20	CATALOGE_GOTLIB
21	PURCHASE_REQUEST
22	OVERDUE
23	AUDIOBOOKS
24	BORROW_RULE
25	CATALOGUE_CINEASTERNA
26	GROUP_ROOMS
27	INTER_LOAN
28	CONTACTS
29	EVENTS
30	TOOLS
31	CHANGE_LANGUAGE
32	NETLOAN_COMPUTERS
33	GAMES
34	APP_LEGIMUS
35	LOST_ITEMS
36	DATABASE
37	ADRESS
38	OPENING_HOURS
39	NAXOS

Table 6. Overview of all the converted intents with assigned priorities.

6. Rasa

6.1 Overview of Rasa

Rasa (Bocklisch, Faulkner,Pawlowski, &Nichol, 2017) is a collection of open-source machine learning tools for developers for conversational AI assistants and chatbots. Rasa consists of two components:

- Rasa NLU is a library for natural langue understanding with intent classification and entity extraction. The NLU processed is defined by a pipeline that contains different components in charge of various tasks.
- Rasa Core is a chatbot framework with primarily machine learning-based dialogues management. The Rasa dialogue manager is controlled by the policies.

Rasa provides users with various pre-configured pipelines and policies for different application situations. However, Rasa also supports customized pipelines and policies. According to the Rasa website (3 May 2020), it already has over 2 million downloads, 9500 forum members, and more than 400 contributors (www.rasa.com). Rasa also offers commercial enterprise solutions with additional services and SLA, which leads to wide applications among the industries.

6.2 Evaluation of some of the existing projects using Rasa

Competitor analysis is often used in software development and e-marketplace to gain competitive advantage by collecting information on other entities (Sheng, Mykytyn, & Litecky, 2005). For our application, it is also desirable to analyze other systems developed with Rasa so that some insights can be acquired how the systems are built based on Rasa and to what extend the technical possibility of Rasa is utilized.

I analyzed 10+1 dialogue systems built with Rasa. These ten systems are in the official showcase on the Rasa website, such as N26 — the leading mobile bank in Germany, lemonade — an insurance company, which claims to use AI for customer handling and Tia – a New York-based app for women's health. At last, I tested the Rasa guidance bot "Sara".

The test identifies primarily the spectrum of the functionality using the categorization stated in chapter 5, the industry, and the channel placing, whether there is human assistance. Additionally, specifications of the system are marked.

	Industry	Dialogical	Functional	Informational	Empathetical	Human assistance	Channel
Lemonade	Insurance	YES	YES	YES	NO	NO	app
No free text input, no free chat flow, system initiative, a simple replacement for analogical form filling. Input box, button.							
N26	Banking	YES	NO	YES	NO	YES	app
Extremely low tolerance for ambiguity leads to a human assistant, simply question answering.							
doodle	Polling	NO	YES	YES	NO	NO	slack
No free chat flow, no structural turns such as greetings and bye, used as a human language parser for appointment data.							
Dialogue	Medicare	YES	YES	YES	NO	YES	app
No free chat flow, system initiative, buttons, and an input box for patients' information and symptoms descriptions.							
Adobe SENSEI	Software	YES	YES	YES	NO	NO	integrated software

Voice-based, integrated into Adobe software, enhancement for the text-based search function.							
Job ai	Recruiting	YES	YES	YES	NO	NO	messenger
No free chat flow, system initiative.							
Tia	Health/Lifestyle	YES	YES	YES	YES	YES	app
Free chat flow, mixed-initiative, seems to be able to capture the emotions of the users							
Unique.ai	Recruiting	YES	YES	YES	NO	NO	web and text message
No free chat flow, system initiative.							
Ergo	Insurance	YES	NO	YES	NO	YES	web
No free chat flow, system initiative, simple question answering bot.							
Eddy Travels	Travel	YES	NO	YES	YES	YES	messenger
Messenger based and limited free chat flow. Heavy use of emojis. Buttons.							
RASA Service bot	Software	YES	NO	YES	YES	NO	web
Free chat flow, somewhat advanced question-answering bot.							

Table 7. An overview of the analysis of the competitive product

Most of the analyzed dialogue systems do not allow free dialogue flow, and the dialogues have to take place following pre-defined templates; for example, lemonade uses the chat interface to replace traditional form filling. The system asks one question after another, and the user has to answer the question in input boxes, and the inputs are validated, the dialogue will not proceed if a question is not answered or wrongly answered.

Another strategy to hinder free chat flow is to use option buttons (graphical user interface) such as in the dialogue app, which handles patients in-take: the symptom descriptions are listed with buttons, and the user can only choose one from the options to reduce the data complexity, which may be useful for medical personnel to interpret the cases. Alternatively, the unique.ai and Job ai offer, instead of buttons, pre-defined phrasing for user input. Users are requested to use the verbal options which tolerate little or no variation.

Four out of ten systems are more or less question answering systems which have no functional components that execute other costumer requests.

In terms of channel positioning, Rasa offers the possibility to connect with messengers such as WhatsApp, Telegram, Facebook, etc. For the virtual librarian project, these channels can also be considered to reach more patrons and users. For example, the City Library Gothenburg is already providing support on Facebook. The barriers to inter-channel applications are low.

All the systems that have empathetical components seem to be only on the first level of empathetical ability, which means the reactions are based on emotional intents, but the system cannot situationally handle user emotions.

To sum up, it seems that the performances of the dialogue systems based on Rasa are still limited. Many systems are still in the stage of simple question answering bot using question catalog and key-word matching approach. Most dialogue systems do not support free dialogue plot, in order to control the dialogue complexity, system initiatives are used. Additionally, to reduce unexpected user's utterance, buttons and phrasing suggestions are often used, in which case the dialogue system can be considered as an articulation machine (although primarily in text for structured forms). The dialogue systems have

not exhausted the technical potential of Rasa, with more advanced dialogue system design; the performance of the system can be profoundly improved.

6.3 Applying RASA for virtual librarian project design

In this section, some technical suggestions are made for the requirements extracted above especially in chapter 3. The recommendations are made specifically for Rasa to support further development and implementation of the system.

6.3.1 Initiative and dialogue opening

According to requests from the City Library Gothenburg, the system should give away that the user is chatting with a chatbot, and the user should have the possibility to talk.

Rasa is an intent-based system, which means the dialogue management acts primarily on detected intents. Based on the user input this indicates to the system the user initiative that the system reacts to. Therefore, Rasa does not talk per default before any intent is detected, and Rasa currently does not offer a default opening message.

The solution is to add an extra *INTENT_START*. It is to be noticed that this intent is only used for the opening line and should only occur once and not be considered into any further turns in the chat flow. The solution is to use a mapping policy in Rasa core and only trigger a customized hard-coded opening line. This way, the start intent is segregated from the further plot. Some of the messengers send automatically "/start" to the bot when a new session is started. In a webchat solution, the message is automatically sent when starting a session and can also be controlled by a script.

After the opening line, the system switches automatically to user initiative, and further switches can be realized through customized action of form actions, since form action is one of the possibilities to allow system initiative. After entering a form, the system will try to interact with the user to fill all the slot of a form until it fills satisfied—the system takes the lead

6.3.2 Slots for metadata

Slots are the memory of a Rasa bot. They are global for the session and ideal for the storage of metadata, for example, the data for account validation such as card number, name, and even credentials. Although this functionality is requested not to be implemented in our case, slots can still be used for some other metadata. For example, they can be saved additionally to the sessions text to analyze how the sensed mood and the dialogue flow are related by simply saving the answer to the question "how do you feel today"(slot configuration in Rasa see below), or capture the frequency/history of library visit by saving the answer to the question "When were you last time in the library?".

```
Slots:

  name: "mood"
```

```
    type: "unfeaturized¹²"
```

6.3.3 Form filling for the search function

The form is an important mechanism of Rasa. The form is delivered with form policy, which offers a frame for a functional request. The submit action of a form can only be executed when all requested slots in the form are filled.

The form mapping policy can also handle complex utterances and fill more than one slot at a time as long as the entities are recognized correctly. The form can be used for the library search function. Depending on the API interface of the Gotlib catalog, specific data can be asked to improve the search result, such as the name of the medium as a mandatory slot and further slots such as ISBN, or format of medium (book, journal, DVD) as optional data. The submit function of the form can be used for sending a structured request string to the API to fetch the search results.

6.3.4 Fallback to fail gracefully

In line with the request that the system should tolerate errors and encourage explorative actions, the threshold of the fallback policy should be set to a low value. The fallback policy has two thresholds, one for NLU and one for Core. The NLU threshold is used to trigger the fallback action when the NLU pipeline yields intent with low certainty, while the threshold for Core triggers fallback action when the system cannot predict the response with enough confidence. The actions can be individually defined distinguishing the fallback actions triggered by low certainty of either NLU or Core.

Another request from the City Library Gothenburg is that the system should tolerate up to 5 retries and give feedback accordingly when it fails to fulfill a user's request. This can be realized by defining a two-stage fallback policy. The two-stage fallback policy puts an additional layer between the intent recognition failure and the ultimate fallback action. The layer is only for NLU, which means that possible intents are transparent for the users but not the next actions. In case of low confidence of intent recognition, users can be asked to either confirm their intent or to rephrase their utterances. In our case the latter strategy is used.

In the NLU training data, a story[13] is added where the first fallback layer is used for five times, and then the ultimate fallback action is applied (the ultimate fallback action is the second stage in Rasa two-stage fallback policy, which can be customized through actions unlike the first stage which can be chosen between "reformulate" or "confirm intent"), so that the system can learn this pattern of behavior from the stories containing the fallback intents.

6.3.5 Customized intent extractor component in Rasa NLU

This thesis aims to support the work package that is done by fellow students and focuses on intent classification of the library dialogues using machine learning techniques. The integration of this module is technically possible through customizing the NLU pipeline.

Rasa offers a set of recommended default NLU pipelines. The essential components are tokenizer, feature extractor and entity recognizer, and intent classifier. The following is an example of one possible

---

[12] "Unfeaturized" is one of the data types for Rasa slots, which is often required when customized actions are used. The other data types are text, categorical, boolean, float, and list.

[13] A story is a part of Rasa training data containing the leaner interactions of intent-response(action).

pipeline. The pipeline is order-sensitive, the output of one component is used as the input for the next component and there is no extra benefit to use more than one intent classifier in the pipeline, since all the results from competing classifiers will be abandoned except the last result.

```
language: "sv"


pipeline:

- name: "SpacyNLP"

- name: "SpacyTokenizer"

- name: "Cutomized_featurizer(Transformer) "

- name: "CRFEntityExtractor"

- name: "EntitySynonymMapper"

- name: "Cutomized_featurizer_intent_classifier"
```

6.3.6 Customized sentiment analysis component in Rasa NLU

To improve the empathetical ability of the virtual librarian, a sentiment analyzer could be added to the NLP pipeline. This may enable the dialogue system to handle the emotions implied by the user utterance situationally.

The challenging part is that the sentiment will be part of the output of NLU and therefore taken as a feature in Core dialogue manager training data. This may considerably increase the complexity of stories in a way that it is not possible to model the dialogue flow for the first development. One possibility is to implement the sentiment analysis in the NLU but use it restrictively during the development stage. For example, an *UTTER_APOLOGY* or *ACTION_REDIRECT_TO_HUMAN* should be triggered only when strong negative sentiment is detected. A possible pipeline can be as following (the underlined elements in the pipeline are those to be created as the research result of Linnea Strand and Robert Rhys Thomas):

```
language: "sv"


pipeline:

- name: "SpacyNLP"

- name: "SpacyTokenizer"

- name: "Spacyfeaturizer "

- name: "Cutomized_featurizer(Transformer) "

- name: "CRFEntityExtractor"
```

```
- name: "EntitySynonymMapper"

- name: "Cutomized_featurizer_intent_classifier"

- name: "Cutomized_sentiment_analyzer"
```

6.3.7 Rasa X and further development cycle

Rasa X is an additional software to the Rasa system with a graphic interface to ease the workflow of chatbot development. Rasa X enables interactive learning and model training, and Rasa X can also be used for version management and corpus management.

The recommendation of Rasa is to leverage conversations to improve the assistant, and a system should be handed to the users for test and development right after the dialog system is able to handle the "happy path" or a basic version of the system with essential functionalities. In our case, we have the advantage that we already have real dialogue data, so that it is possible to train the modeling and then interactively improve it. The training can be done collaboratively by both librarians and developers.

For further development, a knowledge pool for the informational intents has to be built by the library. The collection of knowledge can be expanded on an incremental basis. The answers for one question can be collected first as a whole unit, and the sub-stories within the intents can be developed at a later time (at least after a preliminary version of "happy path[14]" has been successfully implemented). The "openness" and the sense of humor in a Gothenburg way can be partially increased by enlarging the templates (response in the latest version of Rasa) by the local librarians using Rasa X.

Both knowledge pool management and template update should be dynamic and systematical processes. For example, the knowledge regarding opening hours should be updated and changed if holidays affect the regular operation of the library, or, if there are some new and current jokes or news, the templates for dialogical intents can also be updated.

Evaluation of the system should be first carried out before the launch of a beta version of the virtual librarian, based on the real dialogue data with pre-defined key performance indices such as accuracy for intent recognition, entity extraction, dialogue manager response and manners.

6.4 Ethics: data privacy and security in Rasa

Data security is as stated previously essential for a public dialogue system. Rasa ensures the data security through the design that all Rasa components are organized with a decentral solution, which means Rasa does not require any data exchange between the owner of the dialogue system and Rasa server. Rasa does not involve network design. This decentral solution reduces the complexity of data security deployment. The system owner has full control of training data, trained models and other essential components of Rasa.

Rasa leaves the data security issues to the owner and developers of dialogue systems. The virtual librarian is then as safe as the network design itself is. However, Rasa recommends that the best practice should never expose the Rasa Core server to the outside world but rather connect to it from your backend over a private connection (Rasa, n.d.).

---

[14] Rasa uses the term "happy path" for a story, which contains the most fundamental functions and the most predictable interactions

GDPR distinguishes between data controller and data processor. The data controller determines the purposes for which and the means by which personal data is processed. The data processor processes personal data only on behalf of the controller (European Commission, n.d.). In our case, the City Library Gothenburg is the data controller and data processor are platforms and providers such as messengers, webchat toolkits and other databases. The City Library Gothenburg have to make sure that not only the design and development of the virtual librarian comply with GDPR, but also the data processors comply with GDPR.

7. Conclusion

This thesis has applied an explorative approach to work out a framework for the design of a virtual librarian with Rasa. At the same time, the thesis offers a novel workflow for the dialogue system development practice in the industry, especially for small and middle-size organizations, which have little or no IT and software development capacity, and also for cases where there is already collected real primary data. The approach used in this thesis shows a roadmap for a workflow, which requires little linguistic and computational knowledge from the side of the industry, especially of annotators, who are not specially trained for tagging work. The session-topic-based annotation with an expandable tag set can considerably increase the efficiency and better manage the interactions. However, there are also problems such as unhandled dialogical turns and redundancy of intents that can be merged together.

An interview can be used to understand the needs and meta-requirements for a dialogue system. The qualitative approach with narrative input is, in my opinion, irreplaceable to minimize the gap of understanding and can the basis and inspiration for a technical implementation. It can be also desirable if further interviews can be carried out with the patrons.

Corpus analysis based on the distributional characteristics provides us with insights into the importance of different intents and prioritization of the functionalities. Also, it helps to estimate the complexity of the project through the number of topics and their coverage. Regarding the topic modeling, one crucial reflection is that it should be carried out before the annotation work and even before the interview. This may reduce the impact of already formed patterns and topic priming through the discussion and annotation process.

The categorization based on the system response behaviors can profoundly simplify the design of the dialogue system by providing hints how the technical mechanisms should be implemented. The intents with a same or similar categorization may be merged. After an adding, removing, and merging process, the topics are naturally converted into intents, combined with the results from the corpus analysis. Then a list of task packages with remarks regarding priority can be produced which is in accordance with the task package description in system development using conventional approaches.

Rasa is a powerful open-source platform for dialog systems. It is widely used in different industries; however, with potential that is still to be exploited and made use of. For the virtual librarian project, its advantage lies in the possibility to customize the NLU pipeline with extra trained models for intent classifier and other additional components. Regarding data security, all the development process can be done locally and are not dependent on any form of a centrally hosted server. Rasa X offers a development environment with a graphic user interface, which enables collaborative development involving developers, institutions, and end users.

Future work will focus on the implementation of a framework of the virtual librarian using Rasa, integrating of the intent classifier developed by fellow students Linnea Strand and Robert Rhys Thomas into the pipeline to form a preliminary version of virtual librarian which is able to handle the "happy path". At the same time, discussions and planning work should be carried out with the City Library Gothenburg for the creation of the knowledge pool for more detailed question answering.

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Appendices

Appendix I: Interview with questions, answers and comments

Summary:
- The "persona" of the chatbot should be a newly born library chatbot, curious, polite, witty, and has a Gothenburg sense of humor.
- The system should be open and has rather characteristics of an entertainment chatbot than a task-based commercial bot. The main functionality should be informing, only restricted search querying function, but no further functionality demanding personal data is required
- Mix-initiatives. The system should not force the user to follow certain service path.
- Tolerant failure. Retry tolerance for fall-back policy: 5 times. Guidance should be given while responding to failure.
- There is no available knowledge map for the bot design. An efficient way to collect, process, store, and update knowledge should be found.

Q1. Should the users be told that she or he is communicating with a chatbot from the first second?
Answer: Yes
Comment: A message should be sent during the first turn of the dialogue, containing the information that the user is talking with a chatbot.

Q2. Who should start to talk?
Answer: Currently the system sent a default message when a session is started. "What can I help you with...". So the first one really talks is the customer. However, the first turns of the dialogue can be totally unstructured. For example, the user says "hi" or "hello" again despite the fact, that the system has already greeted the user.
Comment: No system initiative requested. The librarian does not guide the user through a certain path. How to structure the opening should be considered to avoid that the users are overwhelmed by information overload so-called "Greeting, Self-introduction, ability description all-at-one-solution", and the system has "mixed-initiative".

Q3. What is more important for you:
a.the chatbot should act like a librarian;
b.get the work done

Answer: a
Comment: EmphasizesT should be set on the imitation of human behavior and polishing the characters of the chatbot. This fits the definition of entertainment bot by Jurasky and Martgin (2019, Chapter 26) rather than a task-based commercial bot. If there is an unsolvable conflict between functionality performance and success of imitation of human behavior. The latter should be prioritized.

Q5. If the chatbot should be enabled with human character, would you please give me a persona to describe it?

Answer: Curious, polite, able to surprise the user with something extra, joke, extra nice greeting, Gothenburg way of joking, witty and relaxed, proper, stick to the subject.
Comment: How to implement these characters? Template design fine-tuning, humor sense, joke list at the backend? Dialect or regional expression optimized by Gothenburg local? Situative emotions with sentiment analysis added in the pipeline?

Q6. How persistent should the chatbot be if users' requests cannot be satisfied at the first try?

Answer: Maybe 5 chances, but with guidance, after that, redirect.
Comment: The limit of times for applying fall-back intent. The user should be "educated" how it can be. The response of the system should not discourage the user to use the system, it should offer some meaningful guidance.

Q7. How do you evaluate the following strategy when the chatbot fails?

a. Avoidance (lead to other intent)
Answer: Yes, I could consider that, but the chatbot should not be persistent and insists on one certain solution.
b. Give some guidance on what the bot can do (personality)
Answer: Yes, the guidance should be given in a way with personality
c. Admit the weakness
Answer: Yes, maybe the bot can say something like"I am a newly born chatbot, I am still learning."
d. Apology
Answer: Yes, but it should encourage the user to explore the chatbot more.
e. Return some other general information
Answer: Yes
f. Return specific predefined information which may be relevant for the request
Answer: Yes
g. Redirect to a human librarian
Answer: Yes
Comment: The need to have a relative open agent is confirmed again, so different strategies can be combined to cope with failure. The connection between different indents should be created so that the conceptual design has a net-like structure.

Q8. Which database do you have?

Answer: For physical books, CDs, DVDs, books printed material-- **Gotlib** (the library has full access, API with advanced functions)

However, the only basic function should be offered by the bot, which means no personal data, no login activity. During everyday work, the librarian can search for the user and give information. If there is further request, such as reservation/hold, only the account identifier (only library card number is asked). The librarian will use Sierra to realize these functions. It is generally desirable to let the users do these tasks by themselves with proper instruction.

Other databases/catalogs:
25 libs
website, app,
cineasterna: for movies
uTalk: language course
Legimus
PressReader

For a human librarian, they have the same access level as the users. So the librarian only referred to these catalogs with functionality and instruction.
Comment: Partially due to GDPR but also the trend to enable users to realize most of the functions by themselves. The functionalities of the chatbot should be restricted to a search query and not more. Any personalized data is not asked, no login and identification processes should be included in the system.

Q9. Do you have a question/answer list for frequent questions?
Answer: currently not.
Comment: The current system completely depends on human knowledge. There is currently no existing knowledge list available for the system. The current chat software has the function to pre-define some message. There have been attempts to standardize greetings (e.g. there are three greetings forms for the librarian to chose).

Q10. Do you think that the user will behave differently when chatting with a bot from when chatting with a human librarian?
Answer: Yes, just out of curiosity, there may be more explorative acts.
Comment: The design of the system should not be 1:1 translation from human-human dialogues, it should openness into consideration.

Q11. Do you expect that a user may get upsets? How about the possibility of abuse?
Answer: I don't think so. If nobody answers, it is even more frustrating. (to the question of abuse) It depends on the performance of the bot. Certainly possible. But more out of curiosity. People want to check how the chatbot works. And based on experience, most of the users are well-behaved in real communication

Comment: Currently, the percentage of not answering is relatively high. The librarians do not

dedicatedly play the role of online customer service, the capacity is limited. It is certainly frustrating for the users not to get a response at all. If the chatbot can reduce the workload and increase the general response rate, it will be a great improvement for the service.

Appendix II: A sub-tags dictionary with description and examples

Nr.	TAGS: DESCRIPTION (if necessary)
1	admin: Internal communication between the librarians (example see below)
2	adress (address): questions containing addresses (example see below)
3	app 'Biblioteket': questions about app Biblioteket (example see below)
4	app Legimus & talbok
5	app Libby / Overdrive
6	app PressReader
7	åsikter, förslag & frågor (opinions, suggestions & questions): general questions and feedbacks (example see below)
8	avbruten chatt (split chat): none response or abnormal/broken chat flow (example see below)
9	bibliotekskort & PIN-kod (library card & PIN) (example see below)
10	biblioteksregler (library rules) (example see below)
11	bok- & ämnessökning (book & subject search): request to find a certain book or subject (example see below)
12	borttappade media (lost library items) (example see below)
13	chatt på andra språk (chat in other languages): chat in foreign language are tagged independently from the content (example see below)
14	cineasterna & DVD film: question about films and the platform cineasterna (example see below)
15	Databases: questions about database (example see below)
16	fjärrlån (inter-library loan): borrowing request from another library or provider (example see below)
17	förseningsavgifter, krav & inkasso (overdue fines) (example see below)
18	fysisk utrustning & verktyg (tools): questions about usage of library equipment and facility (example see below)
19	gotlib katalogsida (Gotlib catalogue): questions about the usage of Gotlib catalogue (example see below)
20	grupprum (group rooms) (example see below)
21	inköpsförslag (purchase request): request and suggestion for purchasing certain items (example see below)
22	kontakt med biblioteken (contact with libraries): question about contact information of libraries (example see below)
23	lån, omlån & återlämning (check out, extend loan & check in) (example see below)
24	låneregler (borrowing rules) (example see below)
25	ljudböcker, CD & mp3 (audiobooks) (example see below)
26	meröppet (extended opening hours) (example see below)
27	naxos (example see below)
28	netloan datorer: computer borrowed for use (Netloan computers) (example see below)
29	No Tag: no tag is assigned for the session
30	öppettider (opening hours) (example see below)
31	programpunkter & kalendarium (library events & calendar) (example see below)
32	reservationer (holds) (example see below)
33	spam: session that are spam or nonsense (example see below)
34	TV-spel (video games) (example see below)

Example for TAG 1:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej

\<librarian\> hej
\<user\> testar lite
\<user\> maxxxxxx(name of a librarian)
\<user\> sorry
\<librarian\> ok, det går bra
\<librarian\> anxxxxx(name of another librarian)

Example for TAG 2:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej
\<librarian\> hej!
\<librarian\> hur kan vi hjälpa dig?
\<user\> adress till stadsbiblioteket ?
\<user\> är det stadsbiblioteket box 5404
\<user\> 402 29 göteborg
\<librarian\> ja precis det stämmer: box 5404
402 29 göteborg

Example for TAG 3:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej!
\<librarian\> hej!
\<user\> länkar som skickas öppnas i detta lilla fönster och blir knepigt att hantera. gillar annars appen. tack.
\<librarian\> a, du menar att du använder våran app biblioteket?
\<user\> går de att öppna i ett eget fönster? kan jag kopiera texten här?
\<user\> ja jag använder appen biblioteket
\<librarian\> det beror på vilken mobil du har.
\<user\> iphone

--DIALOGUE CONTINUES--

Example for TAG 7:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej!
\<user\> jag funderar på att läsa en master (borås) i bibliotek och informationsvetenskap till hösten. jag har en examen i socialt arbete och skulle vilja "bygga ut" min utbildning för att jobba med någon annat. målet är att få jobba på bibliotek. hur ser utsikterna ut kring detta? hur ser kraven/behörigheten för att söka en tjänst med den utbildningen/bakgrunden då jag inte har en kandidat i bibliotek och informationsvetenskap? mvh
\<librarian\> oj, det får du nog höra av dig till bhs i borås och fråga. här på stadsbiblioteket krävs examen i bibliotek och informationskunskap för att arbeta som bibliotekarie, men det finns ju också biblioteksassistenter men det får du kolla med personalavdelningen på kulturförvaltningen. lycka till!

Example for TAG 8:

\<librarian\> hej! vad behöver du hjälp med?

<user> det fungerade inte!
<librarian> hej! ursäkta att det dröjt. vad är det som inte fungerar?

--END OF THE DIALOGUE—

Example for TAG 9:

<librarian> hej! vad behöver du hjälp med?
<user> jag har glömt av min pinkod.
<librarian> det kan du ändra själv på vår hemsida på gotlib eller själv komma in till biblioteket och legitimera dig.

Example for TAG 10:

<librarian> hej! vad behöver du hjälp med?
<user> hej
<librarian> hej
<user> får man ta med sig en hund till stadsbiblioteket i göteborg?
<librarian> oj, jag tror det, kollar och återkommer
<user> ok tack
<librarian> nu fick jag svar och tyvärr inte.
<user> ok tack
<librarian> tack

Example for TAG 11:

<librarian> hej! vad behöver du hjälp med?
<user> hejsan!
<user> söker just nu en bok och jag undrar om ni har någon av dem. isbn
<user> eller isbn
<librarian> hejsan! ursäkta du fick vänta. vi har båda böckerna. du kan söka på isbn i vår katalog online och reservera dom där också

Example for TAG 12:

<librarian> hej! vad behöver du hjälp med?
<user> ?
<librarian> hej!
<librarian> vad kan jag hjälpa dig med?
<user> jag har en borttappad bok sedan april, vad bör jag göra?
<librarian> kan jag få ditt bibliotekskort nummer? då kan jag kolla på ditt konto.
<user> jag kan inte biblioteksnummret, men jag kan ge dig mitt personnummer
<librarian> ja, det fungerar också.

Example for TAG 13:

<librarian> hej! vad behöver du hjälp med?
<user> hej
<user> i have something to enquire about
<user> iam haxxx(name)
<librarian> hej!
<librarian> what can i help you with?
<user> i have borrowed a book and today was the deadline for it to submit at the library
<user> but i was scared to come out because of corona

\<user\> i was wondering what i could in this situation
\<librarian\> okey, i'll do my best to help you.
\<librarian\> do you have a "personnummer"?
\<user\> yes
\<user\> i do
\<librarian\> can you send it to me?

--DIALOGUE CONTINUES—

Example for TAG 14:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> varför kan jag inte kolla på stör
\<user\> störma filmer
\<librarian\> tjänsten vi erbjuder för att strömma filmer är cinesterna. har du testat den?

Example for TAG 15:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hittar inte sidan för databaser lätt på webbsidan.
\<librarian\> hej!
\<user\> hej
\<librarian\> databaser heter hos oss söktjänster.
\<librarian\> följ länken https://bit.ly/39uqxj

Example for TAG 16:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej. är det möjligt att göra ett fjärrlån, från det kongelige bibliotek (https://www.kb.dk/) i köpenhamn, till ett folkbibliotek i sverige?
\<librarian\> hej!
\<librarian\> det kan gå, det är vår fjärrlåneavdelning som avgör vad vi beställer in. det enklaste är om du skickar in din beställning via gotlib, skickar strax en länk!
\<librarian\> https://www.gotlib.goteborg.se/iii/cas/login?service=https%3a%2f%2fwww.gotlib.goteborg.se %3a443%2fpatroninfo~s6*swe%2f0%2fredirect%3d%2fillb*swe%2fiiiticket(=swe&scope=
\<user\> på vilken/vilka grund/-er kan ett fjärrlån nekas?
\<librarian\> det kan vara att biblioteket som har materialet inte vill låna ut det till exempel. eller om det är material som vi själva kan köpa in.
\<user\> tack för svar.
\<librarian\> tack själv :)

Example for TAG 17:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> jag har en skuld hos er jag vill betala. har ni nått bankgiro eller nåt jag kan skicka det på?
\<librarian\> hej! du kan kontakta kravavdelningen på e-post kravet@kultur.goteborg.se så hjälper de dig :)

Example for TAG 18:

<librarian> hej! vad behöver du hjälp med?
<user> hej har ni en kopiator med scanner för utskrift på stadsbiblioteket?
<librarian> hej!
<librarian> ja, du kan scanna och skriva ut här på stadsbiblioteket. du behöver ha ett bibliotekskort med pinkod för att logga in. har du inget kort kan vi ordna ett så länge du tar med legitimation.
<user> toppen tack för hjälpen!
<librarian> :)

Example for TAG 19 & 32:

<librarian> hej! vad behöver du hjälp med?
<user> hej
<librarian> hej!
<user> snälla jag vill ändra min adress
<librarian> du kan logga in i ditt konto i gotlib och uppdatera din adress själv. du loggar in med bibliotekskortsnummer och pinkod.
<librarian> https://www.gotlib.goteborg.se/
<user> tack
<librarian> inga problem :)
<user> annan säk
<user> en bok som heter hemsjukvård av ekrenberg, a. & wallin, l. (2019)
<librarian> ett ögonblick så ska jag kolla
<user> jag vet inte om det möjlighet att har det
<librarian> jag hittar ingen sådan bok, men här är en träfflista när jag söker på titeln hemsjukvård. är det någon av dem? https://encore.gotlib.goteborg.se/iii/encore/search/c__shemsjukv%c3%a5rd__ff%3afacetmedi atype%3aa%3aa%3abok%3a%3a__ff%3afacetfields%3atitle%3atitle%3atitel%3a%3a__orightr esult__u__x0?lang=swe&suite=pearl
<user> hemsjukvård olika perspektiv
<user> är du där?
<librarian> hej
<librarian> jag sa söka!
<librarian> den har vi tre exemplar av. dock är alla tre utlånade, och sju personer står i reservationskö. vill du ställa dig i kö på boken?
<user> jag behöver boken denna vecka.
<librarian> ok jag förstår. då får du söka boken på annat håll.
<user> okej tack

Example for TAG 20:

<librarian> hej! vad behöver du hjälp med?
<user> hej! kan man boka ett lite grupprum hos er?
<librarian> hej!
<librarian> vi har inte bokningar på grupprummen, det är först till kvarn som gäller

Example for TAG 21:

<librarian> hej! vad behöver du hjälp med?
<user> hej, kan man låna eböcker hos er
<librarian> hej!

\<librarian\> https://gotlib.overdrive.com/
\<user\> kan ni köpa in böcker som inte finns där
\<librarian\> ja, vi kan köpa in en del! jag ska länka dit du gör inköpsföslag
\<user\> tack
\<librarian\> https://goteborg.se/wps/portal/start/kultur-och-fritid/bibliotek/lana/lamna-inkopsforslag/!ut/p/z1/04_sj9cpykssy0xplmnnmz0vmafijo8zityzcdqy9tay9_t3mdqwcvymtxxzcxq 28dq31wwkpiajkg-aajgb6bbmhigbz3yus/dz/d5/l2dbisevz0fbis9nqseh/
\<librarian\> :)

Example for TAG 22:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej! vem ska jag kontakta för att få tag på den eller de som är inköpsansvarig för äppelhyllan? mvh linnea eldblom elg
\<librarian\> hej jag måste nog höra vem som är ansvarig. vet inte det på rak arm. känner ju igen ditt namn. kan jag ta din e-piostadress och återkomma?
\<user\> yes, jag jobbade ju förra halvåret på stadsbiblioteket. mejlen är lixxx.elxxx@lerum.se (email adress) tack för hjälpen!
\<librarian\> ger din adress till den som är ansvarig/boel
\<user\> yes, tack igen!

Example for TAG 23:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej kan jag förlänga lånetiden på en bok jag har lånat av er?:)
\<librarian\> hej! det kan du göra sålänge den inte är reserverad av någon annan eller om du inte har kommit upp i max antal omlån. har du ditt lånekortsnummer i närheten så kan jag se om jag kan låna om den till dig?
\<user\> 3000 142xxxxxxx är mitt nummer. gäller matematik boken, har inte förlängt den innan.
\<librarian\> den gick bra att låna om! nytt datum är 25/3.
\<librarian\> du kan också låna om via vår hemsida eller vår app
\<user\> tack för hjälpen du är en stjärna! där ser man, ska kolla upp det omgående, tack för informationen:)
\<librarian\> tack så mycket :) ha en trevlig kväll!
\<user\> detsamma :)

Example for TAG 24:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> är det någon begränsning på hur många e-böcker man får låna?
\<librarian\> ja, fyra svenska e-böckeroch fyra svenska e-ljudböcker per månad. inget begränsat antal på de engelska.
\<user\> har precis köpt en läsplatta och använder overdrive. tycker det är lite svårt att hitta böcker på svenska. tips?
\<librarian\> du kan gå in på de olika kategorierna som kommer i flödet när du går in i overdrive t ex nyinkommet, bibliotekarierna tipsar. sedan kan man också söka via ämnen som man är intresserad av. du hittar ämnen längst upp till vänster under bibliotekets logga.

Example for TAG 25:

\<librarian\> hej! vad behöver du hjälp med?
\<user\> hej!

<user> jag har en fråga
<librarian> hej
<user> hur kan man lyssna på böcker?
<librarian> i appen libby finns det ljudböcker, dock inte så många på svenska än. vi jobbar på det.
<user> bara prova ljudböcker jag såg
<user> finns det annat link
<librarian> https://goteborg.se/wps/portal?uri=gbglnk%3a

Example for TAG 26:

<librarian> hej! vad behöver du hjälp med?
<user> hej! jag försökte precis gå in på biblioteket i nya hovås med mitt bibliotekskort (meröppet) men det fungerade inte, det står något om att det saknas internet connection på skärmen. jag har kunnat använda mitt kort tidigare utan problem så det verkar vara dörren/låset det är fel på. mvh elin
<librarian> hej, ett ögonblick så ska jag svara
<librarian> hej. står det inget om kontaktuppgifter eller liknande om det är problem med accessen? du kan prova att ringa till askims bibliotek, det är personalen där som är ansvariga för nya hovås.
<librarian> deras nummer är: 031-366 31 90
<user> tack!
<librarian> hoppas det ordnar sig!

Example for TAG 27:

<librarian> hej! vad behöver du hjälp med?
<user> hej, när jag får meddelande om att logga in på er naxosböcker när jag vill lyssna på en av dessa böcker, vad gör jag då? mvh

Example for TAG 28:

<librarian> hej! vad behöver du hjälp med?
<user> hej, kan man boka dator?
<librarian> hej! ja, det gör du enklast själv genom denna sida https://www.gotlib.goteborg.se/ . klicka på boka dator och följ instruktionerna.
<user> på 300m2 har vi åtta datorer, de är inte bokningsbara. för
<user> men inte på 300, bara drop in? ;)
<librarian> precis. på 300 kan man inte boka men här på stadsbiblioteket går det att boka.
<user> toppen
<user> kan man boka utan bibliotekskort? har inte mitt med mig... men har kod och personnummer
<librarian> testa med personnummer istället för kortnummer.

Example for TAG 30:

<librarian> hej! vad behöver du hjälp med?
<user> öppettider i kortedala
<librarian> ett ögonblick.
<librarian> 11-
<user> tack!
<librarian> var så god!

Example for TAG 31:

<librarian> hej! vad behöver du hjälp med?
<user> hej , jag vill känna om läxhjälp för svenska, var palats för läxhjälp svenska   varje dag ?
<librarian> hej!
<librarian> vi har läxhjälp för sfi på tisdagar på plan 2 på stadsbiblioteket 16-19, och läxhjälp för högstadiet, gymnasium och komvux på onsdagar 16-18.
<librarian> här kan du också söka efter mer läxhjälpstillfällen på biblioteken i göteborg: https://goteborg.se/wps/portal/kalendarium/kalendarium-start/!ut/p/z1/04_sj9cpykssy0xplmnmz0vmafijo8ziawxdha1ntay9dqw83awc3bzdvdxmzi0ddu31 wwkpiajkg-aajgzq_ejctkfgtsygbu7-rmd9bo3hyweb_zfa_eyibryg_kbdbgggaebepga-lib6wfpr-lhfqylfyrkhquw5-pe5h5duzgqdxpjtajipyxdjlekfggnkpxxl50j5bbmhorfvialjvy6kalbrpfy!/dz/d5/l2dbisevz0fbis9nqseh /#z7_p1da1441k80o00afp1p7kl0md

Example for TAG 32: see example for TAG 19 & 32

Example for TAG 33:

<librarian> hej! vad behöver du hjälp med?
<user> yalla!!!!
<user> yalla!!!!!!
<librarian> hej! vad kan jag hjälpa dig med?

Example for TAG 34:

<librarian> hej! vad behöver du hjälp med?
<user> varför finns det ingen nintendo switch spel att låna i biblioteket?
<librarian> hej!
<librarian> vilken bra fråga! tyvärr har vi inte möjlighet att tillhandahålla spel till alla konsoler. men vi tar med oss frågan och kollar på om det skulle vara möjligt att skaffa spel även till nintendo switch.

Appendix III: Results yielded with topic modelling

Topics interpreted based on the yieled words via LDA-TM:

Number of Topics = 10, Words per Topic: 20

Topic #0: vill boka logga går ljudböcker se ta bra göteborg försöker
kommer funkar grupprum hämta fungerar pressreader appenhej dom får
boken
Interpretation: n.a.

Topic #1: låna ska bokhej personnummer dagbladet gång pinkod bibliotek
testar svenska nästa glömt finns kommer logga ljudböcker lånekort går
hittar få
Interpretation: Problems with pin code, card related

Topic #2: bra vet pressreaderhej lyssna jaghej förstår se använder
böcker daghej myckethej undrar söker barn bara dag ex boken app japp
Interpretation: n.a.

Topic #3: pressreader gp läsa längre appen finns lånekort aftonbladet
svd går kommer låna bara ska undrar via vet tidningar logga problem
Interpretation: PressReader, newspaper

Topic #4: göra svar hjälpenhej stadsbiblioteket ska snabbt finns boken
svenska bara fjärrlån veta söker fått står möjligt bibliotek vilja
hittar åh
Interpretation: Inter-library loan

Topic #5: hejhej ja låna appen verkar gör göteborgs går får bibliotek
ljudböcker via vet nej nuhej just öppet böcker biblioteket tillgänglig
Interpretation: n.a.

Topic #6: to it the you can hittar have is do ner finns thank hitta
böcker book bibliotek bara status hämta stadsbiblioteket
Interpretation: English words, status of booking

Topic #7: böcker bibliotek läsa finns bra tillbaka boken biblioteket
komma trevlig även lämna helg vet hejsan kort idag fick går svenska
Interpretation: Return

Topic #8: boken okhej kommer låna jahej böcker får vill innan lånat
bibliotek via tillbaka lämna fråga bara även fått for göteborgs
Interpretation: n.a.

Topic #9: tackhej okej finns ska låna toppen böcker går står testhej
undrar dethej få boken länge göra använda får vet kunna
Interpretation: n.a.

Topics interpreted based on the yieled words via LDA-TM:
Number of Topics = 15, Words per Topic: 20

Topic #0:
it böcker is can får vet to verkar fått komma tid boken göteborg kanske
 ser kortnummerhej går står tar finns
Interpretation: n.a.

Topic #1:
ljudböcker låna böcker finns hos boken ladda ner lånar biblioteket sven
ska system bibliotek får via hittar lite gång måste få
Interpretation: Downloading, audio book

Topic #2:
låna gör logga göra hjälpenhej hitta ska vill lyssna försöker böckerhej
 böcker boken denhej kunna heter appen går fjärrlån ner
Interpretation: Topics about books

Topic #3:
finns göra vill får går ska fungerar kunna kommer via bra stadsbibliote
ket undrar böcker hoppas bara tusen kort skaffa dit
Interpretation: Grammar words

Topic #4:
ja bra bara vet dag fin funkar kommer boken helg gör måste biblioteket
trevlig ska redan just många libby toppenhej
Interpretation: strongly positive words, politeness

Topic #5:
jahej the appen book of boken böcker ska vecka lämna kommer bara åh oke
jhej tillbaka stadsbiblioteket ny engelska is mvh
Interpretation: n.a. Return

Topic #6:
bokhej jaghej låna söker lånat bra myckethej kommer fick vet daghej hit
ta testar se ggr boken snälla bibliotek fixar förstår
Interpretation: n.a.

Topic #7:
boka you to do have the thank film länge grupprum library går for it bo
ok me 300m2 stadsbiblioteket bibliotek öppet
Interpretation: English words

Topic #8:
okej okhej nej finns pressreaderhej bibliotekhej ska stadsbiblioteket b
ra komma boken hittar även böcker heter fel va stockholm går vet
Interpretation: n.a.

Topic #9:
finns står bibliotek låna går får ska böcker kommer undrar appen plocka
s också reserverat andra status hemsidan hittar möjlighet lämna
Interpretation: Reservation

Topic #10:
ska libby boken igen dethej vet finns hämta låna böcker fråga fixa skic
kar se nya idag söker ta kort svenska

Interpretation: Verbs

Topic #11:
personnummer pinkod lånekort logga hejsan ljudböckerhej ja vill glömt m
åste ska bibliotekskort sitt lyckas kommer första inköp oj tidigare hit
ta
Interpretation: PIN code and login

Topic #12:
hejhej fått innan skicka bibliotek reservera tillbaka nuhej svarahej ve
cka lämna lånade nästa frölunda sverige yeshej hos möjligt dom även
Interpretation: n.a.

Topic #13:
tackhej svar toppen stadsbiblioteket se svenska snabbt läsa testhej bib
liotek dagbladet gp vet hämta får finns böcker genom verkar tror
Interpretation: n.a.

Topic #14:
pressreader gp läsa längre appen går aftonbladet svd via finns hittar t
idningar undrar kommer använder biblioteket gå göteborgsposten funkar b
ibliotek
Interpretation: Newspapers, PressReader