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# Development and Evaluation of a Service Bot in the e-Government Sector

## **Bachelor Thesis**

am Fachgebiet Agententechnologien in betrieblichen Anwendungen und der  
Telekommunikation (AOT)

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# Abstract

Though not a recent phenomenon, chatbots and voice assistants are increasingly gaining unprecedented attention as a successor for mobile and web apps. While still emerging with no defined standards or set protocols, with a hype on the rise, tensions between industry giants with products like Amazon's Alexa, Apple's Siri, the Google Assistant or IBM's Watson unveil new examples in favour of providing an enriched user experience on consumer and business level. The surrounding ecosystem also plays a major role in widening the platforms available while exploring new horizons with alternative approaches and business models. Today voice assistance are already present around indoor spaces, in the car or on the go but are still a new terrain to discover and great potential to unleash.

One such use cases involves the public sector. In this work, we are going to explore Amazon's Alexa and respective platforms to develop a voice assistant for the local city council extending the current chatbot's functionality available on <http://service.berlin.de>. We will touch on the technical challenges and possibilities in implementing a system for eGovernment inquiries and touch on its usability as well as effectiveness in replacing a traditional lookup service. We will then examine the goals we define for our use case to what we were able to achieve with the available APIs and SDKs. With respect to those, we will also report on the limitations developers could face in the process.

Finally, we aim at analysing the current state of voice assistants and service bots in the market and the future of this trend from a technical and a social point of view.

# Zusammenfassung

👉 **NOTE:** translate to German to English or vice-versa.

[ possibility to make inline notes ] **[CITATION]**when a citation is missing

✍️ **To-DO:** todos

**[TO CITE]**

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# Chapter 1

## Introduction

With over a third of the world's population projected to own a smartphone in 2018 [6] and a substantial fraction thereof using smarthome devices on a daily basis, AI's role has become more interesting than ever for productivity and entertainment. Many technologies we take for granted today, such as dictation and word prediction in texting depend on Machine Learning and Natural Language Processing techniques that were only made possible thanks to the high processing power shipped in most devices gradually penetrating the consumer market. This transition also facilitated the introduction of a new form of interaction through conversation with the hardware, paving the way to an aspiration long sought after [3]. Conversational bots were already prevalent since the 80s in the form of Question/Answer systems based on query programming languages like PROLOG and SQL. ELIZA, considered as the world's first chatbot and though quite superficial as an NLP-based programme for psychoanalysis, already at its early stages demonstrated how humans can become emotionally attached to machines, transcending over the anomaly of making conversation not with a human [7]. Today, combining ML with the retrieval-based approach allows a more advanced interaction with the system and yields smarter and more personalized chatbots. Consequently, it is no longer a surprise that chatbots acquire social skills to make Xiaoice, the empathetic bot from China, possibly a new kind of friend made of silicon.



### **To-do: Why Bots**

- den menschlichen Aspekt suggerieren [5]
- menschliches Verhalten imitieren
- smalltalk fähigkeiten
- imagination about ability to react to everything
- For later: how these are centralized at alexa somewhere **SKILLS**
- **Related work:** what are classic use cases for their use with prominent examples? Booking tickets (KLM bot)
- fun bots and more
- unfortunately forums and FAQ pages are not as effective as talking to a human.
- then again, as a customer, if I want assistance, I want the customer to tell me related information that he/she might not know, e.g. model number etc.

#### **biased pros/cons:**

- it would speak as an advantage for bots if they can determine these things automatically z.B.
- besides, I could be a bit more sure in customer support scenario that a bot won't trick me
- as a novice I am usually not sure if the help article / Kbase I am reading is the right one
- and forums have mostly Schrott anyway.
- what bots already achieved is at least not to give wrong answers.
- they could sometimes say idk, which is annoying, but at least it doesn't confuse the user.
- answer suggestions functionality - next step is to get around the user's frustration by making the bot at least more human.

### **To-do: funnel towards Motivation**

- ...modularization and Einteilung of the paper

## 1.1 Motivation

Berlin.de is an online one-stop-shop for appx. 3,7 million residents [1] with **number** average hits daily for information lookup, appointment bookings and even access to local news. As part of a federal modernization procedure with the help of the ministry of interior, D115 was launched in 2009 [2] as a phone service to help residents find relevant information about a public service or municipality, something that can be tricky if a person has no overview of the local government structure and still not always easy even with the help of search engines nowadays. **leading sentence**. Meanwhile, statistics have shown that time spent on messaging apps already surpassed uptime on social media [4], which indicates how the former is more desirable as a communication format

on mobile platforms. It could therefore be worth exploring, how to offer D115 services in a fashion that takes advantage of conversational abilities beyond its personnel.

For now, although local authorities rely heavily on their websites to communicate information to the public, the challenge is mainly finding the right service. In a metropolis with a high influx of expatriates, it is also very likely that certain services are frequently pursued, meaning that helping find the right public service or authority is a repetitive task. In this context, thinking of a chatbot as a public service could have several advantages, like offloading some traffic from the phone service, getting over the language barrier in the case of non-german speakers or expatriates or simply helping customers formulate the right wording for a query in a more intuitive way than using a search box.

#### **To-DO: 2 ¶**

- **Chatbot vs. human:** Analyze differences between bot and human response
  - disadvantage: a bot wants a sentence broken down in small pieces to avoid errors in lengthy interpretation
- **Why can't robots understand us:** language ambiguities - the need to understand context
  - Syntactical: Homonymy
  - Semantic: Metaphors, sarcasm, and puns
  - dialects: enunciations
  - underlying grammar
  - underlying sentiment
- NLP Progress:** How does it help in enriching the bot experience
  - neural networks: help understanding language patterns and get better over time
  - thought vectors: helps connect different words with related meanings
- **wrap-up:** can bots replace services offered by humans? – mention transition from facets (Altavista) to metasearches to all-in-one (Google).
  - chatbots as enablers in customer service industry
  - conclusion: Although not impossible, it is a bit too far-fetched at this stage.

#### **To-DO: Aufgabenstellung:**

- 1- es sollen die Stärken und Schwächen eines solchen System zu analysieren.
- 2- Es sollte zunächst eine Dienstleitung aus dem Berliner Service-Katalog mit dem Chatbot beauftragt werden können.
- 3- Nuancen beachten (e.g. 10243 / FHain)
- 4- Smalltalk Fähigkeiten

## **1.2 State of the Art**

### **1.2.1 API.ai**

### **1.2.2 Facebook Messenger Chatbots**

### **1.2.3 wit.ai**

### **1.2.4 motion.ai**

### **1.2.5 Alexa Skills**

### **1.2.6 Amazon Voice Service**

### **1.2.7 Amazon Lex**

## **1.3 Approach and Goals**

- making the bot become something beyond a Q&A:
- Alexa Documentation
- retaining sessions (explain requests/responses - GET/POST)
- fulfilling intents
- nested handlers
  
- for facebook: implementing the three-answer suggestions
  
- internationalization / customization based on Locale - why is it important?
- many international users prefer a chatbot than a phone since the bot will communicate more accurately, will not have language probs if it understands the foreign lang etc.
- what are other approaches to localization? refer to IRS lecture notes
- use of translators, Stammsprache, etc., detecting the language and say it does not support it.
  
- Alexa Skill will work in germany in english and german -> add english after german
- AL: Anschließend soll das Ziel der Arbeit formuliert werden: Entwicklung und Evaluation eines Prototypen für den Anwendungsfall.

## **1.4 Structure of the Thesis**

# Chapter 2

## Background

 **To-DO:** related work: Wienbot / Singapore

### 2.0.1 Topology of Bots

- use cases and purpose categories (leisure, productivity) - quick survey of respective 'AppStores' - platforms - physical locations (home, office, car, phone, in a business)

### 2.0.2 Information bots

- mention available service types (information system as a "webpage/database")  
- vs an interactive bot that gives you customized information on demand hier soll der D115 Anwendungsfall "Beauskunftung" kurz erläutert werden

### 2.0.3 social bots

- with advantages / disadvantages  
- fake news / online reviews

### 2.0.4 bot-type

- use of ML Handyversicherungsbeispiel  
- from business perspective, the bot is aiming to sell more policies,  
- the bot tries to determine if there is a nuance in the user's answer (machine acting as a judge!) - e.g. "how did the phone fall off" - MKTG - Aufwand


## 2.1 D115

- summarize infobroschuere\_ BMI08324\_screen\_barrierefrei.pdf
- Use case im Detail
- Welche Daten gibt es?
- Was sind die Erwartungen?
- wie kann man die Güte des Systems beurteilen?
- Meist sollte man in diesem Kapitel die Lösung schon im Auge haben, um die Erwartungen so zu formulieren, dass die Lösung auch geeignet ist?

## 2.2 Frameworks and Data Structures (change title)


- AL: Ich würde erst etwas die Algorithmen und Datenstrukturen (Textanalyse, JSON, ggf. Graphen beschreiben. -AL: Anschließend die Frameworks vorstellen
  - AL: Wichtig ist: Aus den Beschreibungen eine Schlussfolgerung ableiten, welche Art von Lösung entwickelt werden soll.
- for current bot:
- Lucene **as the golden standard**: spell check, unscharfe suche, Tika / detect language / ...
  - Solr - explain what's an intent, whats a slot <https://service.berlin.de/virtueller-assistent/virtueller-assistent-606279.php>  
<https://www.itdz-berlin.de/>

### 2.2.1 Intents and Slots

 **To-DO:** explain json

provided in JSON for value lookup, there are

- 616 Intents as `data`, each containing

 **To-DO:** missing variables e.g. are required papers, flag: persönliche Vorsprache ja nein, ...

- `<string> responsibility` denoting in which city halls a service is available
- `<boolean> responsibility_all` a flag set to true in case the service is available in all local authority offices / service points
- `<HTML list string> description` not unified and includes text

- `<string>` not unified and might need to have an `\lstinlineint`— added to it and set to 0 in case service is free
- `<int>`residence
- `<int>`id
- representation
- `<long>`leika
- `<string>` process\_time need to derive minimum, average and maximum service times instead of a string, as well as conditions
- `<string>` name the name of the service that would make sense to a human
- `<node>` appointment with
  - \* link (Key value with URL to /terminvereinbarung page) - check if orphan or if it is for each behörde and in that case how it gets the right one
- `<node>` locations
  - \* hint
  - \* `<int>` location one of the 12 authorities
  - \* url of that service at that authority
  - \* `<node>` appointment (a second one)
  - .
- `<node>` onlineprocessing
- `<node>` prerequisites
- `<node>` links
- `<node>` relation
- `<node>` legal
- `<node>` requirements
- `<node>` forms
- `<node>` authorities
- `<node>` meta

## 2.3 currently deployed bot

- dienstleistungen.json structure (finding the info through hierarchical nodes)
- interpreting the nodes as intents - traversing the nodes (one level up then to next node)
- no session/no persistence

## 2.4 Implementation Possibilities

- structure of Hitlist on berlin.de is provided by ITDZ - as opposed to Versicherungs-firma z.B (ML tries to detect irregular patterns in case customer is lying). - unfortunately forums vs. FAQs did not work. if i want assistance, i want the customer to tell me the model number - and forums have mostly Schrott!

what the bot curently achieved is at least not give wrong answers, sometimes says idk but it doesnt confuse u. same attitude like in german shops (nur unpassende antworten sind frustrierend!

-Vorgehensweise: XML -> index über Lucene - > solr knoten...based on sth like when i say am 10. augustit gets me masalan events..aha august ist ein monat, monat relates to calendar, calendar relates to events



## Chapter 3

# Implementation as Facebook Messenger Bot / Google Action

- as an example for text
- implementing the answer suggestions as buttons
- passing data to the BÃ¼rgeramt terminseite  
<https://console.dialogflow.com/api-client/>  
<https://console.actions.google.com>

# Chapter 4

## Implementation as Alexa Skill

- as an example for voice
- System Specifications
- System Structure
- UML Diagrams
- Design Choices
- scopes and granularity

### 4.1 All about Alexa

[https://en.wikipedia.org/wiki/Amazon\\_Alexa](https://en.wikipedia.org/wiki/Amazon_Alexa)  
<https://medium.com/@robinjewsbury/how-to-create-bots-and-skills-for-facebook-messenger-and-amazon-echo-4>  
- Alexa Appstore had over 5,000 functions ("skills") available for users to download,[18] up from 1,000 functions in June 2016. McLaughlin, Kevin (16 November 2016). "Bezos Ordered Alexa App Push"Paid subscription required. The Information. Retrieved 20 November 2016.

Perez, Sarah (3 June 2016). "Amazon Alexa now has over 1,000 Functions, up from 135 in January". TechCrunch. Retrieved 5 August 2016.

### 4.2 Difference Between Lex and Alexa Skills

<https://stackoverflow.com/questions/42982159/differences-between-using-lex-and-alexa#URL>  
<https://aws.amazon.com/lex/faqs/>  
<https://aws.amazon.com/about-aws/whats-new/2017/09/export-your-amazon-lex-chatbot-to-the-alexa-skills-kit/>

Amazon Lex is a service for building conversational interfaces using voice and text. Powered by the same conversational engine as Alexa, Amazon Lex provides high quality speech recognition and language understanding capabilities, enabling addition of sophisticated, natural language chatbots to new and existing applications. Amazon Lex reduces multi-platform development effort, allowing you to easily publish your speech or text chatbots to mobile devices and multiple chat services, like Facebook Messenger, Slack, Kik, or Twilio SMS. Native interoperability with AWS Lambda, AWS MobileHub and Amazon CloudWatch and easy integration with many other services on the AWS platform including Amazon Cognito, and Amazon DynamoDB makes bot development effortless.

### 4.3 APIs and SDKs

- swagger for handling JSON requests?
- <https://github.com/alexa/alexa-skills-kit-sdk-for-nodejs>

### 4.4 challenges

- und Lösungen dafür
- eine Überführung in Alexa, not writing everything new in alexa. such that when you want to do it in another system what do u want to integrate?
- use external web service maybe? in case that helps instead of alexa doing everything..
- konten hosting to be on alexa
- wo hilft mir alexa, was mach ich lieber woanders?
- Ähnlichkeitsmaße -levenstein-distanz, IFTTT

# Chapter 5

## Evaluation

- benchmarks
- strengths and weaknesses
- challenges
- performance
- usability
- feasibility of using the studied agents
- node.js?
- amazon's system testing options (incl. Betas)
  
- system usability scales (ISO, DIN)
- Con: Alexa skills are listed in the amazon shop page. Sehr unübersichtlich just like prime
- impression: Amazon collects data and makes something "intuitive out of it for you". e.g. fire stick setup already had account linked before connecting to the internet! scary/funny/ but then it could be counterintuitive at some point if u want to do ur own customizations.
- removing bias in recruitment of participants (diversify based on what categories?)
  
- EVAL: AUC/ROC, true positives, false...no of utterances to text
- compare with Wiener Stadportal as a benchmark for a bot  
<https://www.wien.gv.at/bot/> <http://www.vienna.at/wienbot-chatbot-der-stadt-wien-informiert-als-virtueller-beamter/5590853> <https://digitalcity.wien/wienbot-auszeichnung-fuer-chatbot-der-stadt-wien/> singaporebot

## 5.1 Results

usability metrics: - heuristic eval - guidelines (**jakob nielsen, ralf molich whitepaper**)

- biggest usability flaw
- cognitive walkthrough
- step-by-step approach
- questions..will the user try and achieve
- pluralistic walkthrough
- panel method
- hallway testing
- A/B Test
- speed and Bottlenecks

- clientele: census / SOEP, who can use the bot
- make a small prediction (Bus Analytics)
- this Hassloch thing from MKTG

## 5.2 Discussions

- Evaluate the system:
  - is it trivial to build such a bot or not / what is the aufwand
  - how does it react with longer sentences? some service names are long
  - what does levenstein distanz cause
  - wie leicht kann ich eine antwort finden auf das was ich suche?
  - how am i going to classify my tests?
- 
- are chatbots being pushed on the market or is there a demand? (kleine Umfrage basteln?)
  - how easy or difficult it is to make a bot: planing poker - varianz anschauen zw. leicht und schwer und iterativ darüber sprechen
  - wo kann der Kunde (Sawa2 kan el end user or the senat in our case) help optimize the bot masalan bÄ¼rgeramt beyektebo, welche Rechtsgrundlage keine auffällige Probleme masalan zay Perso, PA, personalausweis, how to introduce expert mode so that if u add it with a special character it knows what u want, just like alexa knows when u rename the lamp - refer again to use cases and exper vs personal field

# Chapter 6

## Conclusion and Future Work

### 6.1 Summary

### 6.2 Conclusion

### 6.3 Future Work

- use machine learning to rank higher demands for more popular services.
- matkhoshesh fel 7etta di awi - for now hitlist already given.
- future of bots. deren Einsatz. roles (As judges, catereres in hotels (that hotel botler)

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# Appendices

## Appendix A: Abbreviations

<b>AWS</b>	Amazon Web Services
<b>ASK</b>	Alexa Skills Kit
<b>AVS</b>	Alexa Voice Service
<b>ARN</b>	Amazon Resource Name
<b>MVP</b>	Minimum Viable Product
<b>AI</b>	Artificial Intelligence
<b>NLP</b>	Natural Language Processing
<b>ML</b>	Machine Learning
<b>appx</b>	approximately



## Appendix B: Glossary

<b>Intent</b>	erklärung
<b>Slot</b>	erklärung
<b>Utterance</b>	erklärung
<b>Alexa</b>	erklärung
<b>Alexa Skill</b>	erklärung
<b>Lambda Function</b>	erklärung
<b>Alexa Skills Kit</b>	erklärung
<b>Amazon Developer Console</b>	erklärung
<b>AWS Lambda</b>	erklärung
<b>Amazon Lex</b>	erklärung
<b>Amazon Polly</b>	erklärung
<b>ElasticSearch</b>	erklärung
<b>node.js</b>	Framework built on top of JavaScript
<b>Interaction Model</b>	erklärung
<b>Service</b>	bot, AWS, Berlin.de
<a href="https://docs.aws.amazon.com/general/latest/gr/glos-chap.html">https://docs.aws.amazon.com/general/latest/gr/glos-chap.html</a>	
<b>Application ID</b>	erklärung
<b>Skill ID</b>	erklärung
<b>Bot</b>	Unless otherwise mentioned, yeb2a Cha
<b>Hitlist</b>	erklärung