Technische Universität Berlin

# Survey of Virtual Service Assistant Development (Chatbots)

**Bachelor Thesis**
am Fachgebiet Agententechnologien in betrieblichen Anwendungen und der
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# Abstract

Though not a recent phenomenon, chatbots and their use cases are on the rise in a still emerging market with no defined standards or set of protocols. With the increasing hype comes tensions within and between tech giants and the rest of the industry about providing a complete user experience, recruiting more developers, widening a platform and exploring new horizons that claim to make the consumer's live easier while finding a business opportunity at the same time. And while smaller enterprises use the same circumstance as an incentive and an attempt to grow, chatbots come today in several shapes and sizes but are still a new terrain to discover with their usability, their social impact and their business models.

In this work, we are going to explore different approaches to making chatbots, their presence around the web as well as their trending markets. As a focus, we will present the possibilities available on multiple platforms including Amazon Alexa and Facebook Messenger with a voice and text service bot for public inquiries based on Berlin's official city portal `https://www.berlin.de`. We will then examine its usability and compare the goals we define for our use case to what we were able to achive with the available APIs and SDKs. With respect to these, we will also touch on the challenges and limitations developers face in the process.

Finally, we aim at analyzing the current state for virtual service assistants and the future of this trend from a technical and a social point of view

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# Chapter 1

# Introduction

talk about approaches (retrieval-based models / using ML / NLP...), modularization and Einteilung of the paper

## 1.1 Motivation

Human interaction with machines on an advanced level has always been an aspiration of the future. With evidence in fiction readings Sci-Fi films citation, societies have shown an increasing tendency to avail technologies that make computers present in most domains of our daily lives. And though we still are far from it, we have come a long way in the recent years. With the boom of artificial intelligence and devices making high processing power a tangible option statistic from graph about messenger surpassing social networks - Screen Shot 2017-11-19 at 17.15.18 More and more people "trust" new technologies and the trends resulting from there, be it social media, alexa, selfies and no.. ripple effect - More use 'hey Siri' -¿ results of data collected, what we know about people more than ever before

### 1.1.1 history of bots

- then: eliza psychoanalyzer
- now: Xiaoice: empathetic bot in china

### 1.1.2 Why Bots?

- den menschlichen Aspekt suggerieren(**?**)
- menschliches Verhalten immitieren
- smalltalk fähigkeiten

- imagination about ablitiy to react to everything
- how these are centralized at alexa somewhere -¿¿ SKILLS, amazon.com
- 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.
a- then again, as a customer, if i want assistance, I want the customer to tell me a model number etc.

### 1.1.3   Can they replace humans?

Although not impossible, it is a bit too far-fetched at this stage.
- Difference between bot and human in response
human says long sentences and there is a fluid transition between dialog and monologue
-con: the bot wants a sentence yesharra7a f 7etat soghayara w neshouf..nicht unendlich lang
- otherwise, error margin too large.
- this has to do with human language complexity.
Why can't robots understand us
- language is ambiguous, we need to understand context
–Syntactical: Homonyme
–Semantic: Methaphors, sarcasm, and puns

–dialects: enunciations
–underlying grammar
–underlying sentiment

-progress in NLP making bots great again
-neural networks: help understanding language patterns and get better over time
thought vectors: helps connect different words with related meaingns

chatbots as enablers in customer service industry
reply suggestions function - with the aforementioned techniques, such functionality becomes possible

- 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.
- next step is to get around the user's frustration by making the bot at least more human.

### 1.1.4 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)

### 1.1.5 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

### 1.1.6 social bots

- with advantages / disadvantages
- fake news / online reviews

### 1.1.7 bot-type

- use of ML Handyversicherungsbeispiel
- from business perspective, the bot is aiming to sell more polices,
- 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

## 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)
- fullfilling 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 commmunicate 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

## 2.1 D115

## 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

### 2.2.1 Intents and Slots

provided in JSON for value lookup, there are

- 616 Intents as `data`, each containing

explain json

missing vari- ables e.g. are re- quired pa- pers, flag: persÃ¶nliche

- `<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 `\lstinline`int— 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 /terminveinbarung 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 äm 10. augustït gets me masalan events..aha august ist ein monat, monat relates to calendar, calendar relates to events

# Chapter 3

# Implementation as Facebook Messenger Bot

- as an example for text
- implementing the answer suggestions as buttons
- passing data to the Bürgeramt terminseite

# 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` - 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 ćhatbotsĺo 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 recriutment 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

## 5.1   Results

usability metrics: - heuristic eval - guidelines **(jakob nielsen, ralf molich whitepaper)**
– biggest usability flaw
- cognitive walkthrough
– step-by-step approach

– questions..wil the user tr and achive
- pluralistic walkthrough
– panel method
- hallway testing
- A/B Test
- speed and Bottlnecks

- 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 darÃ$\frac{1}{4}$ber sprechen
- wo kann der Kunde (Sawa2 kan el end user or the senat in our case) help optimize the bot masalan bÃ$\frac{1}{4}$rgeramt beyektebo, welche Rechtsgrundlage ̈keine÷ auffällige Probleme masalan zay Perso, PA, personalausweis, how to introduce ̈expert modĕo 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)

# Bibliography

[1] Hostname. PresName - Radio Replay: I, Robot. Hidden brain podcast. `https://www.npr.org/player/embed/577622555/577666380` (25 January 2018).

# Appendices

## Appendix A: Abbreviations

**AWS**    Amazon Web Serivces
**ASK**    Alexa Skills Kit
**AVS**    Alexa Voice Service
**ARN**    Amazon Resource Name
**MVP**    Minimum Viable Product

# Appendix B: Glossary

| | |
|---|---|
| **Intent** | erklärung |
| **Slot** | erklärung |
| | |
| **Utterance** | erklärung |
| **Alexa** | erklärung |
| **Alexa Skill** | erklärung |
| | |
| **Lambda Function** | erklärung |
| **Alexa Skills Kit** | erklärung |
| **Amazon Developer Console** | erklärung |
| **AWS Lambda** | erklärung |
| **Amazon Lex** | erklärung |
| **Amazon Polly** | erklärung |
| **ElasticSearch** | erklärung |
| **node.js** | Framework built on top of JavaScript |
| **Interaction Model** | erklärung |
| **Service** | bot, AWS, Berlin.de |

https://docs.aws.amazon.com/general/latest/gr/glos-chap.html

| | |
|---|---|
| **Application ID** | erklärung |
| **Skill ID** | erklärung |
| **Bot** | Unless otherwise mentioned, yeb2a Cha |
| **Hitlist** | erklärung |