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

Bachelor Thesis
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Declaration of Authorship

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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 applications. 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 or the Google Assistant unveil new examples for providing an enriched user experience for consumers and businesses. The surrounding ecosystem also plays a major role in spreading 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 in our pockets on the go. They live inside smartphones, on fancy TV sets or even as stand-alone devices. Yet, they are still a new terrain to discover and great potential to unleash in numerous contexts.

One such scenarios involves the public sector. In this work, we explore the Alexa Skills Kit by Amazon in combination with respective services to develop a voice assistant for the local city council giving a parallel experience to its current Virtual Citizen Assistant (Virtueller Bürgerassistent) available on http://service.berlin.de. We touch on the technical challenges and possibilities in implementing a Software as a Service (SaaS) system for e-Government inquiries and analyse its usability as well as its effectiveness in replacing traditional information lookup. We then examine the goals we define for our use case to our achievement with the APIs and SDKs available at the time. With respect to those, we also report on the opportunities, challenges and limitations faced in the development process.

Finally, we study the current state of voice assistants and service bots on the market and the future of this trend from a technical and a social point of view.
[*Supervisor*] CONCLUSION: DAS ERGEBNIS DER ARBEIT SOLLTE MAN ZUM SCHLUSS NOCH IM ABSTRACT ERGÄNZEN.]

Zusammenfassung

Chatbots und Sprachassistenten sind nehmen ein wachsendes Interesse in den letzten zwei Jahren. Im Gegensatz zum öffentlichen Email-Protokoll, konkurrieren Groß- und Kleinunternehmen auf eine universale Systemausprägung und diversifizieren mithilfe von künstlicher Intelligenz den Rahmen für den persönlichen Assistenten der Zukunft. Ob es durch Amazons Alexa, Apples Siri oder den Google Sprachassistenten hervorgeht, zeigen sich zahlreiche Beispiele, wie die Nutzererfahrung auf privaten oder Geschäftsebene weitgehend bereichert werden kann. Der steigende Nutzen von Sprachassistenten zuhause, im Büro und unterwegs erlaubt viele neue Erkenntnisse und Erfahrungen, die dem Marktumfeld zu verdanken sind.

Auch auf staatlicher Ebene wird dieser Nutzen vertreten und wertvoll eingeschätzt. In der folgenden Recherche untersuchen wir Alexa von Amazon im Zusammenhang mit anderen verfügbaren Plattformen und erweitern die Fähigkeiten des Sprachassistenten durch den Webauftritt des berliner Stadtportals (BerlinOnline) um weitere Dienste sowohl für die vielfältigen und mehrsprachigen Einwohner der Hauptstadt als auch deren Senatsverwaltung. Als Grundlage wird auf die Funktionalität des Virutleen Bürgerassistenten Berlins zurückgegriffen. Anhand dieses Anwendungsfalls werden die prinzipiellen Möglichkeiten und Herausforderungen bei der Implementierung eines Sprachassistenten für die Stadtverwaltung aus technischer und organisatorischer Sicht analysiert. Zusätzlich wird die Usability des Systems als Ergänzung für einen Abfragedienst in Erwägung gezogen.

[Supervisor] CONCLUSION: ERGEBNIS SOLLTE ZUM SCHLUSS NOCH IM ABSTRACT ERGÄNZT WERDEN.
KEINE PROZESSE, SONDERN ERGEBNISSE.
KEINE TEMPORALE ADVERBIEN]

Acknowledgements

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Chapter 1

Introduction

With over a third of the world's population projected to own a smartphone in 2018 [31] and a substantial fraction thereof using smarthome gadgets and appliances on a daily and even hourly basis, the role of Artificial Intelligence (AI) has become more interesting than ever in many disciplines including but not limited to productivity and entertainment. Many technologies we take for granted today, such as dictation and word prediction, recommender systems or other digital analytics depend on Machine Learning (ML) and Natural Language Processing (NLP) techniques that were only made possible thanks to the high computational power shipped in most devices gradually overtaking 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 modern societies have been striving globally [19]. Whether in blockbuster 60s drama as seen in "Breakfast at Tiffany's" (1961) or in Sci-Fi romance in the movie "Her" (2013), an obsession with voice technologies is featured throughout from an answering machine on tape to a fully personalized but mass-produced voice-based operating system to even become a protagonist.

Conversational bots were already prevalent since the 80s in the form of Question Answering 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 [37]. Today, combining ML with retrieval-based approaches allows a more advanced interaction with the system and yields smarter and more personalized conversations between man and machine. 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 revoking the fiction element from "Her".

So far, voice assistants represent an additional layer of abstraction from software beyond the graphical user interface (GUI) and are hence the closest we have come towards human communication. They deconstruct another barrier between the user and the hardware as voice communication generally does not require profound computer literacy and the conversational models rely on our inherent ways of expression. As they simulate the human aspect and imitate its behaviour for instance with small-talk abilities [30], voice assistants are regarded as a convenience for daily tasks and are on their way to becoming a de-facto replacement to sophisticated actions we perform on the screen. In fact voice searches now compose a large market segment with over a billion voice searches per month [1] and are predicted to make up about "1 Billion Voice Assistant enabled devices in circulation by the end of 2018" [1] and 30% [12] [33] of all searches by 2020 with currently highest rates coming from the youngest generations based on a survey [38] by Global Web Index. According to the Alpine.ai 2017 Voice Labs report there were 33 million voice-first devices in circulation in 2017 worldwide [2] with tremendous shifts in number of units sold between 2015 and 2017. This and more statistics hint at a revolutionary change towards our use as much as the introduction of the GUI and mouse were to the Command Line Interface (CLI). Increasingly, we recognize voice as a *new* user interface, also known as Voice User Interface (VUI), and analyse good practices and design guidelines for it.

Since sound and voice are primal stimuli in the human brain [15], using them becomes more instinctive, making us in turn process our ideas starting with an "inner voice" that translates easiest into words when we speak it before routing or "funneling" it to actions [6]. Arguably, on a market scale, this gives voice assistants today a competitive innovation advantage (CIA) for they are hence more accessible to further demographic groups with a growing wider acceptance.

Meanwhile, statistics from BusinessInsider [21] show that time spent on messaging applications (apps) already surpassed average uptime on social media, which indicates how the former is more desirable as a communication format on mobile platforms and how having a conversation is an easier way to interact with a device instead of downloading an app for every task. Further, the speech-to-text/text-to-speech domain has become more powerful with steadily increasing processing power, an effect of Moore's law we only get to understand lately in addition to the gradual lessening of the dominance of Chomskyan theories of linguistics (e.g. transformational grammar) [8]. With an integration in most modern operating systems, speaking to a device has become no longer a absurd novelty. Inadvertently, the Google voice assistant built into its Android OS currently with the highest usage shares among computer and smartphones [9], supports understanding of multiple languages in the same sentence for multilingual interaction. Moreover, the Echo Dot recorded the peak for best-sellers

for 2017 on Amazon with unprecedented numbers showing a high customer retention and satisfaction rate [27]

As we constantly challenge our expectations towards technology, our imagination makes us question the ability of AI to make a machine able to react to everything we say, which can be not too far-fetched in a near future. Although we are still far from this step, at least for the consumer level, we dedicate a lot of effort to make it happen with examples like IBM's Watson or other Uses of big data analytics. We can probably conclude though, that as long as we still do not exactly understand human intelligence in detail yet, it is hard to fathom AI as a holistic field. As such, it is therefore more realistic to consider the current works in the field as *intelligence amplification* [6] empowering human take better decisions beyond their normal brain processing power and not overtaking human intelligence as some might claim.

1.1 Motivation

With the aforementioned, we try to think how voice assistants could come handy and why we want to invest in such technology, juxtaposing it to available alternatives. If we consider human workforce (i.e. customer service agents) on one hand, it is commonplace that these are more expensive, less available due to restrictive working hours and not always aware of the full circumstances related to an issue they are supposed to fix or a question they are to answer. Sometimes knowing more about a person could almost become a dangerous tool since it gives room to manipulate them. A client in a shop for instance can have their decision influenced by the seller and eventually get tricked into buying a product based on wrong advice. Although there is practically little the client can normally do to circumvent misinformation if that seller is replaced by an algorithm, having an automated system like a voice assistant step in gives at least a more neutral impression since it are not directly expected to act with malicious intentions like a vendor who abuses the client's trust.

Since the point of availing voice assistant is to act in a person's interest, we also want an information system not to confuse us or to limit our cognitive abilities. Besides, we can at least ensure in a system design that a voice assistant will not become moody and intentionally want to make our lives harder for this reason as opposed to a human. And so, although a voice assistant or a chatbot may not potentially answer every question we throw at it, we want to at least presume that it would give us no information instead of partial truths or lies while keeping a certain level of neutrality and "decency" in terms of the wording. This is why most credible companies elaborate explicitly in their terms, conditions and privacy statements on what makes them accountable on

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the the services they offer. A consumer therefore feels more empowered to assert any faults originating from an automated system than from a human and conditionally has an assurance that they can prevent any violations more systematically.

Eventually a person is more likely to develop a certain kind of trust in a machine more than in a human once the technology is established and widespread. Cars, email, and other gadgets or services we take for granted today are living proof of how inevitably this trust grows, for the better or worse and depending on the degree of affinity to the related technology, aversion or ignorance in a business sector. Trust in a system can grow once it is certified to have little to minimal exceptions. Besides enriching the value chain, it is a key in setting a technology to become an industry standard. Therefore, if a voice assistant is shown to deliver reproducible results disregarding a person's profile, this definitely contributes towards the credibility of the system. This is however not an easy case, since an advanced voice assistant is not expected to be deterministic in most situations, otherwise it becomes boring! We elaborate later in this thesis how we handle this problem.

On the other hand, Information Retrieval Systems range from web pages (e.g. frequently asked questions section (FAQ), forums or a search engine). These are in some cases even less effective than contacting a human as getting the proper information takes a lot of time, or the level of trustworthiness or participation levels in a forum are particularly low, the problem stated is too broad or too specific compared to the answer we are seeking. A user also could come unintentionally across false positives in a search and rely on irrelevant information without knowing. Furthermore, some case-related information might be required to have a proper understanding of a situation or a scenario and provide adequate answers. For Example, if a user would like to know if a certain accessory is compatible with their mobile device, they might need to give a model number, which they may or may not know. Consequently, it is of high interest to maintain a system that could determine all these factors autonomously or with the least possible human interference such that a system supersedes the abilities of the classical Q&A approach.

Internationalization is also another factor to take into account. Since languages differ not only in their vocabulary but also grammar, word and sentence structure (e.g. false friends, nuances, phrases, idioms), developing a voice-first device requires a flexible infrastructure and software stack both able to accommodate these deviations. In that respect, not only is region-specificity important, but also being able to cater for people in a region who do not speak its official language or are residing there temporarily. Especially in businesses where it's difficult to hire skilled foreign-language speaking personnel, a voice assistant can overcome this challenge as it would communicate more

accurately and will not have language problems. The customer is then given the option to avoid an inconvenient experience with the typical scenario with a call centre representatives where neither of both parties understands the other. For those who have minimal understanding of the language, there are possibly also options to provide help in the native language if the user is given the options he/she can answer a prompt with. At the very least, a VUI could still give feedback to the user of wether it understands the language or not, since algorithms for detecting a language are not as complex as answering the question once the language and its dialect (also known as locale) is deciphered. All of which are optimal use cases for ML approaches and algorithms such as term weighting discussed in Section 9.4 based on simpler approaches to localization from an original text, such the corpus-based mapping approach. WordNet is one such example. Finally, giving the user clues on what to answer with is also a helpful tool, as we will also discuss in bot design (Chapter 6)

1.2 The Analyzed Scenario

Berlin.de is an online one-stop-shop for approximately 3,7 million residents of the German capital [3] with thousands of visitors daily for information lookup, appointment bookings and even access to local news. As part of a federal modernization procedure with the help of the German Ministry of Interior, D115 was launched in 2009 [14] 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 with the array of public services provided. To promote information accessibility, D115 continuously aims at expanding its reach and services. It is therefore worth exploring, how to offer D115 services in a fashion that takes advantage of conversational abilities beyond its human personnel or online city portals.

For now, although local authorities rely heavily on their websites to communicate information to the public, the challenge is mainly finding the right service even with an vague query since most of the time a person requesting a public service is not fully aware of the exact service name in the catalogue of services offered or cannot differentiate between two similar public services or even know if one of them is required in their case. In a metropolis with a high influx of incomers, 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 voice assistant 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, expatriates or simply helping native customers formulate the right wording for a query in a more intuitive way than using a search box.

All of which leads to thinking how providing voice assistants and/or a chatbots for public services could make us reap the benefit of available technologies and extend it aiming for continuous modernisation of our connected living to blend into a seamless digital lifestyle [13].

1.3 Approach and Goals

In the following thesis, we take these factors into consideration and narrow them down to fit our scenario tailored for the e-Government sector. We start by surveying industry-standard voice assistants platforms and frameworks and present a solution that caters for the local municipality of Berlin, Germany. For this we choose to present our solution using the Alexa platform based on our criteria in Section 4.3.

With an agile approach, we present functional code for running and deploying the aforementioned service on Amazon's voice assistant through a so-called ALEXA SKILL (referred to here from here on as 'Skill') and analyse the strengths and weaknesses of choosing this option. We start by exploring information on the public services offered through https://service.berlin.de to understand how to implement our Skill. We then choose a set of exemplary public services use cases with different levels of implementation difficulty to prototype how all current and future Berlin.de's services should be handled using knowledge from an existing database operating the current VIRTUAL CITIZEN ASSISTANT discussed in Section 2.4. Difficulty is expressed as the required knowledge by the Skill to perform a user's request. This includes for instance the system's abilities to understand the district location intended by the user through only a postal code input.

Further, we test the Skill using unit tests **[*Supervisor*] NOT REQUIRED BUT NICE TO HAVE]** for the code and usability tests for the interaction model especially with the ability to identify and deal with different inputs from various users]. In the implementation, we already have the advantage of being part of Alexa's system to entertain the user with many small-talk abilities which allows us to build on its existing and continually expanding database for question-answer models.

In summary, these goals were defined for the system:

- We want to understand user's requests about public services through different sentence formulations.

- We want to deliver differently relevant parts of information based on the service requested (e.g. cost, processing time).

- We want to communicate with an API endpoint that builds on the service catalogue of Berlin.de's VIRTUAL CITIZEN ASSISTANT.

- We want to produce a scalable, modular system that can be extended in the future.

Further requirements are discussed in Chapter 6.

1.4   Structure of the Thesis

This thesis is organised as follows: In Chapter 2 we talk about use cases of chatbots and voice assistants in the public sector, show related work and introduce comparative examples through e-Government solutions in Vienna, Austria and Georgia, USA. We compare them to the current chatbot application VIRTUAL CITIZEN ASSISTANT available on service.berlin.de [1], which we build our work on with the same underlying technology using Apache Solr.

Going beyond a theoretical analysis of the voice user interface paradigm in ⌈ Chapter ⌋ 3 We shed light within the State of The Art context in ⌈ Chapter ⌋ 4 on the available platforms in Section 4.3 and explain why we choose Amazon, going over the idea behind Alexa's Skills and explain the structure of Amazon and Amazon Web Services Ecosystem to operate Alexa in ⌈ Chapter ⌋ 5

In Chapter 6 we introduce our design of the Skill and discuss how it addresses redundant boilerplate code, small-talk abilities and briefly highlight some limitations of the system. We also present the frameworks and Application Programming Interfaces (APIs) we use in our own implementation, the prerequisites and artefacts provided initially through a breakdown into several cases simulating top common uses on Berlin's city portal ⌈ mention section when it's written ⌋ .

Chapter 8 explains our implementation solution. We elaborate in particular on how we deal with individual public services in the interaction model from front-end and back-end perspective, how we connect the web services together and analytically document the code structure, endpoints in addition to the deployment process.

The related implementation code is available on GitHub [2] with a digital copy attached to this work.

Chapter 9 evaluates our implementation with respect to our target in the defined use cases. We base our evaluation models on a survey we conduct that helps us specify requirement details, as well as automated tests provided by the framewor we use in addition to usability, performance and unit tests.

In Chapter 10, we conclude the work focusing on how our implementation is attainable through Alexa and where future works can be directed for an e-Government solution.

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[1]`https://service.berlin.de/virtueller-assistent/`
[2]`https://www.github.com/megantosh/AlexaImAmt`

✍ TO-DO: make sure this is final URL and is public before printing

Chapter 2

Background and Related Work

As our motivation stems from the unstoppable worldwide trends of digitalisation, in this chapter we discuss current application categories with respect to chatbots and voice assistans and talk about governments' efforts in keeping up with these trends as part of their modernisation stream in the age of social media, Internet of Things (IoT) and the interaction between both. We then show relevant examples in our context of voice assistants.

2.1 Topology of Chatbots and Voice Assistants

Chatbots and voice assistants come in numerous mouldings; on the web, in apps, through smartphones or as a combination of those and beyond. In Barot and Oren [34] we observe the different purposes the industry caters for. As we witness the integration of chatbots in retail, productivity, entertainment and create more possibilities for their existance, it is obvious that the trend will continue for a while before the market is saturated. Similar to marketplaces for applications like Apple's App Store and the Google Play Store which have become a commonplace term even though their slow stagnation in the recent years, chatbots and voice assistants are predicted to remain trendy for some time as VoiceLabs predicts (Figure **??**). Moreover, SearchMetrics advises on SEO tweaks for Google Voice Search [18] show how voice assistants are becoming a ubiquitous market.

Google Actions

2.2   Digitalisation in the Public Sector

There is no doubt that social media has changed the shape of our society in the last twelve years. Not only by affecting the way we communicate, but also by generating immense amounts of data, creating new jobs and disrupting economies en masse. Meanwhile, governments are continuously striving to market their image in more creative ways than ever to target more segments in society. From what used to be a novelty, politicians' tweets are now a highlight in main news sections. The sudden interest of governments in social media platforms can be seen as an attempt to become more transparent and reach more public awareness. It is more likely for instance that a 15-year old would find out about a public figure (including a president) by following their story on Instagram than by reading news about them on dedicated news website.

This is ultimately because the social media platform, as part of many new technologies are designed with the focus of reach in mind much more than only availing information to the target. We distinguish between the pull-based model of information retrieval, where a person would actively look for certain information usually through

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looking something up, vs. the push model, where the information is 'thrown' to the user without them actively asking for it, usually by subscribing to the source or news outlet and more likely through audiovisuals than trough text. Unsurprisingly, such platforms become a key player in redefining fame, identity and image.

The push-model is a new strategy to dissemination of knowledge, which governments embrace [23] to bridge the gap in their outreach to the public. Although the digitalisation trend in governments generally emerges from the desire to expand infrastructure for information exchange and availing open government data [35], digital media has now become an integral part of it, too, making it inseparable from many institutions compositions.

In Germany, many advanced milestones in digitalisation were attained in the last years. From eliminating paper in many administrative workflows to funding successful start-ups in the field (e.g.Aaron.ai [17]) and seeking renewable energy as a foundation to power an exponentially growing number of devices in the country with a reduced carbon footprint, the aspect of digital media has been relatively neglected compared to other countries. According to numbers from the United Nations' E-Government Development Index in 2016, Germany ranked 15th worldwide and 8th within Europe with an average of 0.82 , substantially outranked by the United Kingdom, the United States, Singapore and France. Outperforming its previous statistics from 2014 where its index scored 0.79 with a world average of 0.47, where it was also outranked by Austria, Israel and Bahrain [5] in addition to the aforementioned countries as listed in Figure 2.1. Germany's ranking went up from 21st to 16th worldwide in the last two years.

Figure 2.1: Top Ten Countries for E-Government Development Index in Europe based on [35]

Country	Region	Sub-Region	OSI	HCI	TII	EGDI	EGDI Level	2016 Rank	
United Kingdom	Europe	Northern Europe	1.0000	0.9402	0.8177	0.9193	Very High	1	
Finland	Europe	Northern Europe	0.9420	0.9440	0.7590	0.8817	Very High	5	
Sweden	Europe	Northern Europe	0.8768	0.9210	0.8134	0.8704	Very High	6	
Netherlands	Europe	Western Europe	0.9275	0.9183	0.7517	0.8659	Very High	7	
Denmark	Europe	Northern Europe	0.7754	0.9530	0.8247	0.8510	Very High	9	
France	Europe	Western Europe	0.9420	0.8445	0.7502	0.8456	Very High	10	
Estonia	Europe	Northern Europe	0.8913	0.8761	0.7329	0.8334	Very High	13	
Germany	Europe	Western Europe	0.8406	0.8882	0.7342	0.8210	Very High	15	
Austria	Europe	Western Europe	0.9130	0.8396	0.7098	0.8208	Very High	16	
Spain	Europe	Southern Europe	0.9130	0.8782	0.6493	0.8135	Very High	17	

*Note: The Ranking Trend lines display the country rankings, with 1 being the top ranked and appearing at the bottom of the vertical axis, and 193 being the lowest ranked and appearing at the top of the vertical axis. Therefore, the lower is the graphical point, the higher is the ranking. The horizontal axis represents the survey periods of the *UN E-Government Survey*, i.e. 2003, 2004, 2005, 2008, 2010, 2012, 2014 and 2016.

the E-Government Development index (EGDI) is composed of a calculation based

on proportionally normalised averages of the Online Service Index (OSI), the Human Capital Index and the Telecomunication Infrastructure Index. When it comes to engagement through e-participation, Germany performance lies also in the top quartile. Its Online Service Index performed 21st worldwide (Figure 2.2), which shows the continuous strive to maintain relatively many rights to access government information online and an open data government policy on the web.

Figure 2.2: Online Service Index for Top 30 Countries Worldwide based on The UN Department of Economic and Social Affairs [35]

United Kingdom	Australia	Singapore	Canada	Rep of Korea	Finland	New Zealand	France	Netherlands	United States	Austria	Spain	Estonia	Emirates	Sweden	Japan	Italy	Israel	Slovenia	Mexico	Germany	Lithuania	Bahrain	Serbia	Norway	Malta	Colombia	Denmark	Uruguay	Chile
1	0.9783	0.9710	0.9565	0.9420	0.9420	0.9420	0.9420	0.9275	0.9275	0.9130	0.9130	0.8913	0.8913	0.8768	0.8768	0.8696	0.8623	0.8478	0.8478	0.8406	0.8261	0.8261	0.8188	0.8043	0.7971	0.7899	0.7754	0.7754	0.7754

In an age where we take the internet for granted, we also expect to have multiple communication channels open to government representatives and public authorities. Hence, out of public interest, governments are advised not only to focus on digitising their internal structure, but also their representation on the public sphere. Especially at times of change like with the introduction of autonomous driving and the regulations related to it, transparency is a continuous expectation from the people. As stated above, since transparency heavily relies on public presence, which in turn depends on availing more communication platforms, voice assistant services are definitely worthy of consideration in that context.

2.3 Worldwide Examples of Bots in E-Government

Knowing that the Online Service Index of a country consists of the services available to different groups of society, we can argue that vulnerable groups (i.e. the poor, persons with disabilities, older persons, immigrants, women and youth) can be easily marginalised in this index. Another statistic by the German Federal Statistics Office (Statistisches Bundesamt) shows that most online public services in 2016 were targeting persons of age 25-44 with an equal offer of services for age groups 45-67 and 16-24 with the least amount of services targeted at youngsters between age 10 and 15 comprising 15% of the service catalogue (Leistungskatalog, LeiKa) [32]. For that reason, we acknowledge the importance of inclusion especially towards vulnerable groups in the process of expanding a online public service.

This gives us the advantage to promote in the development process of a chatbot or a voice service assistant for inclusion especially since the domain is relatively still uncharted. As Zehlike et al. conclude, given the many possible biases Machine Learning Algorithms can result in [24], a holistic approach is required to have a balanced distribution of services in different fields (e.g. Health, Finance, Administration) for different groups of society (protected and unprotected groups). Already offering a service on platform that offers less constrains to the user than a browser's graphical user interface (GUI) allows per se more options for inclusion but could also be limiting of the system reacts to a vocabulary used only by a certain group for instance.

In terms of functionality and testing of a chatbot or voice assistant system on inclusion metrics, WitLingo [1], a company which builds voice-driven apps for banks, universities, law firms as well as other public and private sector enterprises believes in that sense that "getting feedback [on the performance of the voice service to different groups of people] is more important than measuring ROI" [28] with a report that reflects the same statement in the retail sector from Voysis and Retail TouchPoints [36].

While there are several cities such as Singapore and Los Angeles integrating chatbots and voice assistants into their administration's websites and coming up with all sorts of interactive solutions, for this research we choose the City of Vienna chatbot service WIENBOT[2] given that it uses German and the Alexa Skill GEORGIAGOV[3] for a comparison in US English, as we examine both languages in our development process.

WIENBOT

developed for Vienna, Austria mention who they are developed by etc. Aquaponics etc

✍ TO-DO: pics of interface and conversation

GEORGIAGOV

developed for Georgia, USA mention who they are developed by etc. Aquaponics etc

✍ TO-DO: pics of conversation

> The state of Georgia has always been on the forefront of web accessibility. For example, from 2002 until 2006, Georgia piloted a time-limited text-to-speech telephony service which would allow website information and popular services like driver's license renewal to be offered to citizens [11]

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[1] https://www.witlingo.com/
[2] https://www.wien.gv.at/bot/
[3] https://www.amazon.com/GeorgiaGov-Interactive-GTA-Ask/dp/B074XBQGTQ

While we are less interested in the content delivered through the voice assistant and have no access to AskGeorgia from the German Amazon Store, we use the US store for our conversation testing purpose to pick the relevant design of flow of conversation.

2.4 Berlin as a Use Case

As Schwarzer et al. state, few systems are available that "enable Berlin's citizens to inform themselves of governmental services" [22]. As part of the modernisation process, the VIRTUAL CITIZEN ASSISTANT (VIRTUELLER BÜRGERASSISTENT) was born in ⌈ developed by ⌋ the Information Retrieval and Machine Learning Competence Centre of the Technical University of Berlin's Distributed Artificial Intelligence Laboratory.

✎ **TO-DO**: - structure of Hitlist on berlin.de is provided by ITDZ - as opposed to Versicherungsfirma 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 lmny shops (nur unpassende antworten sind frustrierend!

✎ **TO-DO**: - LeiKa - 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? **do not forget the surveyu made**

- Meist sollte man in diesem Kapitel die Lösung schon im Auge haben, um die Erwartungen so zu formulieren, dass die Lösung auch geeignet ist?

✎ **TO-DO**: say that the bot is developed as a webapp using groovy.

if anything about AllInclusive is to be mentioned, it should go here or before it can go in implementation section.

We cover here an excerpt of basic elements that we will later see more or less in the same structure of the JSON file containing the interaction model:

Figure 2.3: `Dienstleistungen.json` - Primary Nodes
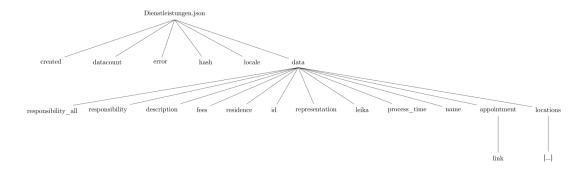
Figure 2.4: `Dienstleistungen.json` - secondary Nodes

provided in JSON for value lookup, the structure of the file is as follows: there are
⌈ carry on - the structure ⌋
started with 616 Intents in `data` node (now 685 or so), each containing ⌈ ⌋

Table 2.1: relevant nodes in query results `Dienstleistungen.json` - Description

key	type	ex. Value	description
`id`	`int`	326233	public ser
`d115URL`	**URL** `string`	"https://service.berlin.de/dienstleistung/326233/"	link to pu
`d115Name`	`string`	Fiktionsbescheinigung	public ser
`ssdsAll`	`string`	...	additional
`d115Description`	`string`	...	Introducto

Chapter 3

The Voice as a User Interface

We start with a juxtaposition of Voice User Interface (VUI) to the Graphical User interface (GUI) respective to cognition and behavioural design which gets us to define new terminological foundation that will follow throughout this thesis.

3.1 GUI vs. VUI

Visuals and Sounds can both communicate the same message even though they use a completely different medium. One one hand, the premise that "a picture is worth a thousand words" can be valid based on the image but only assumes that we want to give a clear picture to the receiver. Communication through voice, on the other hand, can generally allow more room for interpretation. We think of an example where you would watch a football game on TV vs. the same game on radio, where listening to it allows each person in the audience group to imagine a different game for themselves, even though the match result are the same.

When we use written text, be it in a document or a street sign, or any label, we seek to mostly assure that all receivers understand the same message with a universal codification of what we want to express through the language we use. In this process, language becomes the common denominator for understanding and the short written text becomes purposefully designed to give in the best case a message not open to interpretation and so a foundation for an agreement or contract between the source and the destination of the message. It is a good medium of reference.

3.2 Utility of Voice

The utility of Voice comes handy with its different paradigm in numerous settings. For a passenger at the airport or an employee between meetings, it can be more effective

to ask questions through conversation than transform them into a query then type them on a screen, or visually navigate on a web page / mobile application until we reach the information we want. In a 2016 Cisco Systems (formely MindMeld) survey [26], of 1800 users of voice assistants, 61% see that the primary use of a voice assistant is when hands or vision is occupied. Today, this goes further beyond the simple use-cases to become an integral part of our fast-paced life, where we see companies like Ecobee getting around 40 percent of their sales through voice-based AI [4] since their embrace about two years ago. The 10-year-old company's CEO elaborates that their customer "[...] have to fight traffic to get home, and then they have to feed the kids, diaper the baby, and who knows what else. [Ecobee] give them a hands-free way of getting something done while they're in the midst of other tasks."

Also, in terms of accessibility, blindness could sometimes make voice the only possible way to navigate or be aware of one's surroundings, e.g. a blind person crossing a street depends on the sounds coming from cars and traffic lights. In that sense, voice can allow people to do their activities free-handed and unobstructed by actively engaging into reading activity, for instance having to look on a screen. As our ambitions in connectivity become more complex, we have become more dependent on our phones in the last decade. This is where use of a Voice User Interface could have the advantage of liberate us from the constant usage of our smartphones and moving from one screen to another. However, it is noteworthy that the trade-off between information exchange visually and through audio comes at a price. While both have their own advantages and disadvantages, it is important to understand that the context in which the medium is used is an important factor.

Hence, we need to differentiate between GUI design and that of a VUI. Since we come from a GUI background thanks to the World Wide Web standards with HTML and CSS, it might not be most intuitive to apply the same concepts on VUI design simply since we start from the mindset that the GUI dictates how to use the software and the user has to understand this interface and deal with it as is.

> ✍ TO-DO: ghaleban mesh mazbouta hena ba3d el refactoring eli 7asal

3.3 Why Can't AI understand us

AI has made giants leaps in the last few years. Thanks to neural networks, bayesian approaches in classification, decision trees and many other theories, we are capable of performing rigorous analyses on datasets Considering that speech is one of the most complex forms of such, there are still various challenges that do not have a single strategy to tackle.

> What makes voice-based AI so appealing to consumers is its promise
> to conform to us, to respond to the way we speak—and think—without

requiring us to type on a keyboard or screen. That's also what makes it so technically difficult to build. We aren't at all orderly when we talk. Instead, we interrupt ourselves. We let thoughts dangle. We use words, nods, and grunts in odd ways, and we assume that we're making sense even when we aren't [4].

When speech meets AI, there are a lot of language ambiguities to deal with and multiple contexts to understand. Since this is a field by its own and the amount of problems we can face with understanding natural language is unlimited, it is not the scope of this thesis. We only briefly survey a few categorical examples in the following:

- **Sytanx**: homonyms such as "I *present* you a *present*." or "The *fly* wants to *fly*"

- **Sematics**: metaphors, sarcasm, puns such as "it's raining cats and dogs"

- **Underlying Sentiment**: such as "oh yeah, sounds very exciting" when it's not.

- **Dialects**: enunciation such as [dɪˈvɛ|əpmənt] *(British)* and [dəvˈ|ɑpmənt] *(Indian)*

While Machine Learning enables us to decode phrases not in the classical way in the past by randomly guessing the whole expression, our speech datasets grow and require analysis in further breadth and depth to deliver a sustainable Natural Language Understanding (NLU) engine. So far, in the past six years our primary approach has changed due to the little progress made with it. Instead of trying to understand exact meanings, we work from "imperfect matches at the outset, followed by rapid fine-tuning of provisional guesses" [4]. The learning part is involved by reinterpreting missed expressions [16]. On one hand, neural networks help us understand language patterns and better the more frequently we use them, but can fail in the case of homonyms. [20] Thought Vectors on the other hand complement them by controlling the connection of different words with their related meanings

Depending on the system, it is therefore a rule of thumb that most AI-powered personal assistants like Siri or Alexa are in their early learning phases. In order to be able to make use of them in the future, the painful immaturity part has to come in effect. This limits us for instance to using short sentences to lessen the probability of the system misunderstanding us. And so, naturally, what distinguishes a good system from a better one is how fast it learns.

Interestingly, a side effect of this indeterministic technique is that the voice assistant inadvertently simulates a person, who can sometimes not hear us, asks us to repeat a sentence or explain it in a different way. Although this is the same idea that a good system should have minimal fault tolerance, it is unprecedented to tackle a computer system on the consumer level with the idea that we might very much hit or miss the action we want to perform. On the other hand, though premature, it is evidence that a human has much more authority to a machine-powered brain.

Yet, although it might seem at the beginning that moving between both paradigms is easy, the more detailed system design gets, the trickier it becomes to transform GUI elements into text. Particularly with long texts. We will go over this in more detail about voice design guidelines in Section 6.3.

> ✍ **TO-DO**: this is a refactored todo. read in context and see if it fits here
>
> **- 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

3.4   VUI Semantics

Having the visual or haptic interface disappear is therefore a game changer for as soon as the user does not have direct instructions on how to deal with it, they start to improvise, or rather move away from the idea that the interface constrains them to the illusion that they define that interface and can control it. For instance, the user knows that they have to press only on a certain area of the screen to activate a button and actively move the mouse to that part. In other words, when a user sees a 'save' button on a dialogue box, they relate to it in their head that the functionality behind that button lies in committing and keeping a persistent copy of the current state of the parent file to that dialogue. The label 'save' describes in a visually expressive fashion what the user can or cannot do within this *dialogue state*.

In voice on the contrary, a user is uninhibited in what they can and cannot say and the system is supposed to understand the *intention*of the user with *the formulation*they just used.

In order to translate the aforementioned with less ambiguity, we need to define the lexis we use for voice design utilized in most common chatbot and voice assistants constructs. We divide the building model into intents, utterancesand slots The Fulfilment part is taken care of through a back-end endpoint containing the programming and business logic to the interface, which also validate the slots before sending it onwards, similar to what JavaScript checks would do on a website.

3.5   Terminology

We already unveiled in Section 1.3 that Alexa will be the underlying system. Thus we cap the elementary definitions of voice assistants with distinct Alexa-specific concepts and give meaning to the following terms:

Intent

As the intention the user pursues with a spoken sentence. This translates to the action being executed upon the user's command based on mapping his/her words to this action.

Utterance

As the wording a user picks to express his intent. For instance, to set the volume on a TV to quieter, we could say "turn it down a nudge", "It's too loud" or "lower the volume". Although all three sentences have the same meaning, linguistically, they are fully unrelated and only context makes us understand them, e.g. we have to know that "it" refers to the TV set in close proximity.

Slot

As a variable fo a certain type we define in our programme that belongs to a category of items. For instance, when someone says they would like to order a *large* coffee, they assume that there is the option to have a small coffee, too. And so large and small refer both to the size of the coffee. Programmatically, we define `large` and `small` to be of type `size` of the coffee. Similarly, if there is the option to order a tea and a Cappuccino, it would be only fair to define `cappuccino` and `tea` to be of type `beverage`. Consequently, **slots** can be defined to any part of the sentence, where a parameter (here beverage or size) can be grouped into **slot types**.

This idea is to be handled with care, though, since technically in most languages we can define a subject, a predicate and an object. Here is an example in English:

$$\underbrace{I}_{subject} \cdot \underbrace{would\ like\ to\ have}_{predicate} \cdot \underbrace{\overset{\text{number of items}}{a} + \overset{\text{size}}{large} + \overset{\text{beverage}}{coffee.}}_{object}$$

When we design a voice system from scratch, we might have to make it understand how each of these sentence elements can be interchanged with another one of the same slot type. However, since utterances build on they idea of slot types, we can make delegate the system to understand what is important from the sentence through slot types and what other interoperable words are not relevant. In this example, if we say:

$$\overbrace{My\ brother} \cdot \overbrace{wants\ to\ order} \cdot \overbrace{a + tall + coffee.}$$

it is not important to they system to understand at this stage who is going to drink the coffee. It should be more concerned with the intent; making the coffee, e g. sending a signal or instruction to a coffee machine.

Ultimately, it is up to us to draw the line on where we want to define a variable slot, that is relevant to the sentence being said by the user in context at a certain time in the conversation flow and where certain sentences would be as a whole giving the same intent

Synonym

As a word that has the same meaning of another word that fills a slot. For instance, if we assume that a user says "I want a **cup of jolt**" they system should still be able to understand that they want a standard coffee. If, however, the user defines the type of coffee beans they want, such as 'java' or 'arabica', the system should still be able to differentiate between these and not consider them both as the plain 'standard coffee', fulfilling a different intent.

Dialogue State

Like with a state machine, when we have a conversation with Alexa, the dialogue goes into states STARTED, IN_PROGRESS or COMPLETED in the dialogState property of the JSONs being exchanged with the Alexa client (e.g. an Echo Dot). This is helpful for delegating the dialogue to Alexa or handling it in our own code especially in a multi-turn conversation. More details about this interaction available in the ASK DOCUMENTATION [1]

Dialogue Directives

Entity Resolution

Fulfilment

Interaction Model

Multi-Turn Conversation

---

[1] `https://developer.amazon.com/docs/custom-skills/dialog-interface-reference.html#scenario-delegate`

Over-answering

Persistence and Memory

Chapter 4

State of the Art

> ✍ **TO-DO**: intro sentence

4.1 Analogies to the Introduction of Web 2.0

> ✍ **TO-DO**: web 2.0 was a weird word we didnt use and it became a hype then suddenly it disappeared after it has been defined.
> it started with RSS and HTML stardards upgrade and now it's totally obvious where it goes.
> no one uses RSS, but facebook and the idea of a feed would have not been born have we not started with RSS

> ✍ **TO-DO**: - **wrap-up:** can bots replace serivces 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.

[*Supervisor*] MUSS EVTL WEG BZW NEED TO EXPLAIN RELEVANCE] With these introductory definitions we try to lay out a foundation for a standard, which is still in an experimental phase. Much like when tablets and smartphones were introduced to the market, the languages and framework used to render GUIs for the users had to adapt, e.g. with HTML5 and CSS3. In that transition, the experimental phase can be considered when browsers had to render a different page depending on the client. It started with a certain few screen resolutions that can be fixed, to offering a desktop and a mobile version and finally to the spreading of responsive design, the MPEG4 H.264 codec for video and so forth. When screen sizes and aspect ratios became also so diverse that it was hard to keep track of, website designers saw the importance of using

different relative measuring units to present the website correctly (e.g. percentages for CSS classes, ems for fonts, etc.)

4.2 Development Models and Platforms

Chatbots have become available and more accessible to develop through numerous platform (for the same platform (Facebook), for your own platform(Lex), just a tool (Flask)). We no longer have to come up with the whole infrastructure.

> ✎ **TO-DO**: **by platform:** -API.ai / Facebook Messenger Chatbots / -wit.ai / -motion.ai / Flask
>
> Amazon and Microsoft agree their voice assistants will talk (to each other) - additional plugins are in the making, giving individual touch of sound based on profile (Alexa Podcast on the way to BXL)

4.3 Choice of Platform

> ✎ **TO-DO**: I'll have to introduce skills in this section for the first time. reference it in glossary in two places. here and later in Alexa + skills

> ✎ **TO-DO**: moved from intro(was too detailed for up there):
> like Siri, Bixby, etc. ⌈ put bixby somewhere else and be more precise on what u did based on section choice of platform ⌋ such as Microsoft Azure Bot Framework, Amazon Lex and API.ai,

	Alexa	API.ai	Microsoft Azure
price	free [1]	free	free

Before deciding to develop for Alexa, we consider several options and evaluate their advantages and suitability for our requirements.

With Alexa as our choice, we agree to acknowledge the following considerations:

Availability

```
https://developer.amazon.com/docs/custom-skills/
develop-skills-in-multiple-languages.html
```

The skill is available only in the German skill store, due to the selected country distribution.

The skill can be used by customers in Germany who have set their devices to use German.

The skill can be used by customers in Germany who have set their devices to use English (UK).

The skill cannot be used by customers in Germany who have set their devices to use English (US) or any other language.

The skill cannot be used by customers in any other country, regardless of the language they've selected for their devices.

✍ **TO-DO**:
Intent fulfilment - mention how ability to react to everything is centralized at alexa somewhere **i.e. talk about SKILLS**
- ability to retain sessions (explain requests/responses - GET/POST)
- fullfilling intents
- nested handlers

skill service: code - business logic - handles json requests skil interface: configuration (developer portal)
- difference to Lex & Polly : diff alexa lex

- Major prob: lex is not in german
- Alexa Documentation

Chapter 5

Amazon's Ecosystem

In this chapter we discuss Amazon's state-of-the-art strategy as it is important to introduce the implementation scope of voice assistants top down prior to exploring the current context after comparing it to other approaches in the larger context of conversational bots as a whole from a technical and user experience point of view.

5.1   Amazon Web Services (AWS) + Alexa

Getting started with Alexa as a platform for the first time might seem a little overwhelming especially since each component of it is being constantly restructured since its debut release in November 2014 and with Q4 2016 being the beginning of its major market penetration success [12]. As throughout the course of this thesis these major changes occurred, we discover that Amazon's philosophy and success is based on the divide and conquer principle on a large scale. This allows loose coupling of all sorts of components of the company, starting from their business logic to even their branding themes.

AWS

Amazon Web Services is a Cloud Computing service provider with a complete set of services to help build and run web applications "reliably and securely at a cost and scale" according to one's independent needs [29]. It comes with agile abilities to adjust to various solution at a flexible scheme with benefits like multiple server farms globally (operating under different legal contracts with respect to data security and user privacy), caching, NoSQL, DevOps and so forth.

Alexa + Skills

Alexa is a cloud-based voice service assistant platform by Amazon powering millions of devices ⌈ with {number of requests} daily—monthly ⌋ on its own-branded IoT devices like the Echo, Echo Dot, Tap, FireTV as well as cross-platform through mobile apps available through Apple's AppStore for iOS and Google Play Store for Android devices. Unlike Apple's approach with Siri for instance [1], where including support for third-party integration on iOS's Service Development Kit (SDK), Amazon decided with the launch of Alexa to include non-Amazon developers right from the start by introducing a multitude of (SDKs) around the platform as part of AWS, e.g. Alexa Skills Kit SDK discussed further below.

So far, though the separation of AWS and Alexa's environments is not linguistically intuitive with the company's name labelled on every service component [2], Amazon.com, Inc. offers an array of web services through AWS that summarize all building blocks necessary to operate Alexa as a software for end-users. Of course with the introduction of the aforementioned devices, it becomes intuitive to call these 'Alexa devices' since their primary purpose is to operate as Alexa clients. We refer to Alexa here only as the service offered by Amazon to consumers. Consequently, although Alexa comes as a fully packaged service to end-users, we can reduce it to a compilation of many micro-services provided by AWS. As most of these are available separately in the form of Software as a Service (Saas), we conclude that AWS incorporates the following components required to make Alexa come together and becomes a consumer of its own web services platform.

5.2 AWS Modules as Alexa's Building Blocks

✎ **TO-DO**: logos in Illustrator - (as a legend) they are used in graphic later on

listed in sequential order of importance, Alexa's service modules include but are not limited to:

Lex [3] *for conversational interfaces using Natural Language Understanding, Text-to-Speech and Speech-to-Text*
"a service for building conversational interfaces into any application using voice and text" [29]. While Lex is the most important backbone to make Alexa possible and can be a main operator of another software package to create a whole new category of voice assistants and conversational bots independent from Alexa, Siri etc., development for Lex was not available in German at the time of this research.

---

[1]as know from its policy on new software and hardware products like the case with the iPhone, the Mac, etc.

[2]see Etymology in Annex 10.3

We therefore decide to use the Alexa Skills Kit, which ultimately takes advantage of Lex and the other components described below under the hood. Lex and Alexa use the same deep learning techniques for natural language processing with the workflow described with the example in Figure 5.1 below. More information on Lex and its difference to Alexa are discussed in Appendix 10.3.

Polly [4] *for speech synthesis*
another "service turn[ing] text into lifelike speech, allowing [developers] to create applications that talk" [29] wile harnessing the power of deep learning. It is more or less the mouthpiece of Alexa built on top of speech synthesis algorithms.

Transcribe [5] *for automatic speech recognition using Speech-to-Text*
which "makes it easy for developers to add speech-to-text capability to [...] applications" [29]. With Transcribe we are able to get text out of the user's voice before passing it into a format Alexa's backend would understand.

Lambda [6] *for intent fulfilment*
Although Lambda is a versatile "service [built] for a variety of real-time serverless data processing systems" [29], it can be used as an integrated server instance to host back-end code for intent fulfilment.
Pricing: First Million calls are free. Billing charges per operation millisecond.

DynamoDB [7] *for persistence storage*
Acting as a very fast NoSQL database service while also using tables, Dynamo is very scalable and can be primarily used in the context of Alexa as a persistence holder for data collected during the interaction with the user to give Alexa a 'memory'.

S3 [8] *for resource storage*
standing for simple storage service, it is a safe instance for cloud storage using buckets (namespaces) with various access management and encryption options. The first 5 GB can be stored for free.

CloudWatch [9] *for event logging*
CloudWatch acts like the console for an operating system. It monitors all low-level events happening within the AWS sphere. In combination with Lambda it comes as handy tool to log events resulting at runtime once a Lambda instance is called and its code being executed and is used for debugging.
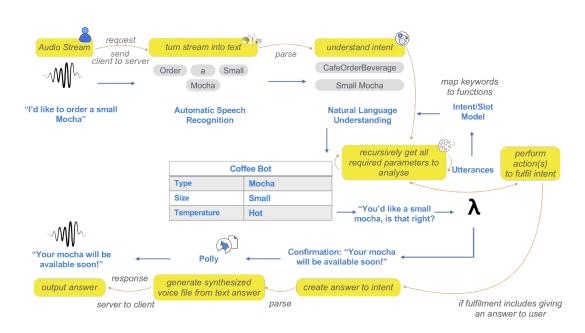
IAM [10] *for identity access management within AWS*
Identity Access Management (IAM) is a secondary service module regulating in the Alexa context in combination with Lambda the routing rights between internal Amazon endpoints. It also ensures compliance policies are enforced within and

between AWS modules, as well as between AWS modules and other external services.

Cognito [11] *for identity access management beyond AWS*
    like the rest of AWS's platform, Cognito is a scalable service module to perform user authentication and can be used in combination with an external endpoint instead of Lambda.

Figure 5.1: Interaction between AWS modules in the use case of a "Coffee Bot" based on Niranjan [16]

putting different combinations of these and other building blocks interactively together generates the model for Alexa. In a world increasingly operated by Internet of Things (IoT), we describe a possible interaction in the example here for a use case of a hypothetical chatbot that operates a coffee machine using some of these service modules (Figure 5.1). Although this graphic describes how an end user would combine these modules to set up their own chatbot, this is the same workflow that Alexa uses. Hence, with Amazon's use of its own micro-services we infer that takes advantage of these to build a whole new ecosystem putting Alexa Skill developers as producers, end-users as consumers, and the Amazon website and Alexa App as a marketplace to mediate between the products (Skills) the developers produce to their target customers (end-users, country-specific or worldwide). From a marketing perspective Amazon achieves through Alexa a vertical diversification of its product programme (where existing AWS

services result in a new product expanding the value chain) while simultaneously offering an extension of its aggregator model (as opposed to a marketplace model)by playing as a mediator between the developer's role and that of the end-user's

we can therefore describe the meta-model for Alexa similar as one of an application with several front-end and back-end components acting in a DevOps environment of cloud micro-services. Unlike in most GUI-based scenarios with an MVC design pattern [7], where the user uses the `controller` to manipulate the `model`, which in turn updates the `view` appearing to the user, in a VUI scenario, we need to consider that the user's paradigm to the `view` component is quite different. Before we dive into the VUI paradigm, we introduce Alexa's own implementation of it for third-party applications (i.e. Skills). These are broken down into the following elements for users and developers:

Alexa Skills Store

[for End-Users] where someone with an Alexa-enabled device can preview a Skill before installing it, Once installed, the own instance of Alexa becomes "smarter" by that Skill, which does not need to update from "client side", since it is only linked to the Amazon account and not hosted on the client (only sends requests through it). This offloads the user from the overhead of thinking about updates since these happen in the back-end.

Alexa Skills Kit

[for Developers] Although it is hard to define it as a complete SDK for Alexa and it is still in a continuous expansion phase, it is responsible for compiling the loosely coupled tools provided by AWS and others to act as an interface for the skill from a developer point of view. This fits into the rest of Amazon's scheme of focusing on interoperable micro-services that fit multiple purposes. It includes the following essentials:

Alexa (Developer) Console

This is where all the developed Skills live. It is the gateway to the front-end of the Skill or Voice service (described below). It provides a web interface for initial setup of the Skill, a structured representation of the JSON Files that include the LANGUAGE (INTERACTION) MODELS, the SKILL PROPERTIES, the endpoints it uses and accounts it links to. Throughout this thesis, the console has undergone major interface upgrades and additions to its core functionality. Currently it is also the place where submitting the skill for publication happens and where the simulator (discussed below) lives.

31

ASK CLI

A Command-Line Interface tool that interacts with the Alexa Console skipping the web browser. Although not at a stable release yet, it has numerous functions to creating, deploying and testing our Skills. Available through the Node Package Manager (NPM) [12]

Alexa Voice Service

A service for accessing cloud-based Alexa capabilities with the support of AVS APIs, hardware kits, software tools, and documentation. Through the Alexa Voice Service Amazon has simplified the creation of conversational interfaces for device makers, allowing developers to add Alexa and intelligent voice control to new products for mobile phones and cars to smart speakers and home appliances. It simplifies building voice-forward products by handling complex speech recognition and natural language understanding in the cloud [13]

5.3 Skill Structure

Finally, after presenting the core stones that take part in administering the Skill, we move on to the Skill structure. Ultimately, the elements discussed above are represented in JSON files that together with the back-end of the skill make up this web-app like composition. Because of its flexible file format, Skills back-ends can be built using one of multiple runtime environments including Node.js, Java, Python, C# and Go. Not coincidently, these are the same languages supported by AWS Lambda

Disregarding the programming language used for development, these statically generated files are included in the code:

`skill.json` The Skill manifest file including its publication name on the Amazon website, invocation name in each language, a description of the Skill readable by a human, author of the Skill and other properties ⌜ maybe include our sample in Appendix ⌟

`<locale>.json` The interaction model of the respective language. It is named after the locale the file is in and includes all slots, utterances, dialogues, custom defined slot types inter alia (file structure in Table 6.1).

`<packageFile>` A manifest file for required dependencies (installable through NPM for instance in the case of Node or Maven in the case of Java) for installation to run the web-app in Amazon's cloud.

---

[12] through `\$ npm install ask-cli`
[13] `https://developer.amazon.com/alexa-voice-service`

5.4   Alexa Interfaces

Briefly going over the options available to use Alexa, we present and compare the different Hardware product lines and software solutions developed by Amazon or compatible with their voice assistant in terms of usability configurations, i.e. presentation of voice and graphical interfaces.

Hardware

The following devices are Alexa-enabled out of the box. The voice service is either accessible through voice command within the same room or an active button press on the device.

Table 5.1: Currently Supported Alexa-Enabled Devices in Comparison

	Speaker	Tablet	SmartHome	TV
Models	Tap, Echo - Dot, - Plus	Echo Show Kindle Fire	Echo Spot	FireTV Stick
Screen	No	7.0"	2.5" round	HDMI Display
Line Out	Yes	Show: Bluetooth Kindle: Yes	Yes	via HDMI
Alexa On	Voice Command	excl. Fire HD 10 Button Press	Voice Command	Button Press

Software

while the hardware models stated above are possibilities for testing, too, they do not always serve as a primary testing environment. There are sometimes more optimised ways to automate Skill testing, for instance by running scripts that would send the transcribed text in the appropriate JSON format. This is helpful for multi-turn conversations and retaining sessions, so that one does not need to repeat the full conversation until one reaches the test breakpoint.

Alexa App designed to be a control unit that operates most Alexa-enabled devices, is not an Alexa interface[14]. However, apart from being a tool apart from Amazon's website to install Skills and manage accounts linked to Amazon (for music streaming and

---

[14]yet (although this will change soon)

other related content-based services), it is a very useful tool to track the history of conversation that took place through a respective Amazon account. We use it mainly to hear what we said and see how the text was interpreted using Lex's NLU engine. It helps for checking homonyms and nuanced utterances.

EchoSim.io "a browser-based online community tool for developers that simulates the look and feel of an Amazon Echo" [15].

Reverb An iOS / Android app, allowing the interaction with the Alexa instance linked to an Amazon account. A perfect option to make a qualifying device alexa-enabled [16].
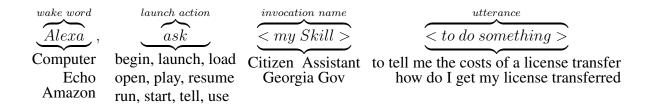
Alexa Simulator Alexa's own web-based online simulator giving JSON responses and voice feedback to the requests sent and is part of the ASK. We interact with it either through voice or with JSON requests.

CLI Simulator the command-line tool of the aforementioned simulator. Accepts strings and file uploads from the CLI and returns responses to the same interface. Obviously because the Skill is a web service in the cloud, the CLI also requires an internet connection [17].

Speaking with Alexa

We end this chapter by explaining how Alexa is designed to operate from the user's point of view particularly for Skills. A full guide is available in the ASK DOCUMENTATION in multiple languages. [18]

A conversation starts with any of the four wake words below, followed by the launch request, then the invocation name and lastly the utterance to action. Here is an example in English.:

wake word	*launch action*	*invocation name*	*utterance*
$\underbrace{Alexa}$,	$\underbrace{ask}$	$\underbrace{< my\ Skill >}$	$\underbrace{< to\ do\ something >}$
Computer	begin, launch, load	Citizen Assistant	to tell me the costs of a license transfer
Echo	open, play, resume	Georgia Gov	how do I get my license transferred
Amazon	run, start, tell, use		

---

[15] https://echosim.io/

[16] https://reverb.ai

[17] running command $ ask simulate --text <inputText> --locale <inputLocale>

[18] https://developer.amazon.com/docs/custom-skills/
understanding-how-users-invoke-custom-skills.html

Chapter 6

Skill Design

> ✍ **TO-DO**: *moved from availability section in choice of platform:*
> We choose to offer our skill only in Germany because our Skill's functionality is specific only within this geographical region. For that we configure the Skill to handle English (US) and German.
> Consequently we will two interaction models and two handlers.
> say why we do it like this 3ashan each language group has a different interest although we can do a handler function for two languages but we prefer not to 3ashan ne3melha schöne und nicht systematische implementierung.

> ✍ **TO-DO**: intro on structure of chapter
> - to then elaborate on implementation requirements in section 6.1. - on Skill design: nobody cares abt ur skill - functional requirements (although this is not OCL now, but requiring an SSL cert.) / non-functional (bot muss höflich sein)

we say first decision was to go for alexa so we see what we kind of frameworks we need around it

> ✍ **TO-DO**: then talk about how you researched on alexa's available skills and found out that the e-Government sector is underrepresented and hence you chose this as ur analyzed scenario.
> fluidly contiuning from intro and background:
> - since among Apple and Google it hast the voice-first devices best equipped for its platform, a user base larger then its competition and provides the most mature API and SDKs.
>
> - We choose this skill scenario since it is underrepresented in that pie chart. ...
> - amazon as a platform is compared to apple and google readiest (check ref voicelabs)

Table 6.1: Interaction Model Schema (Skill Management API) [10]

Field	Type	Description	Required	
`languageModel`	object	Conversational primitives for the skill	yes	
`__invocationName`	object	Invocation name of the skill	yes	
`__intents`	array	Intents and their slots	yes	
`____slots` (Intent Slots)	array	List of slots within the intent	no	
`__types`	array	Custom slot types	no	
`__samples`	array	Sample utterances for the intent	no	
dialog				
elicitationRequired				
elicitation				
type (slot type)				
name (slot name)				
prompts				
`__` id				
`____`variations				
`_____`type				
`_____`value				

✎ **TO-DO**: It's important to say that they do not transcribe, but do term weighting etc, a black box, and that we will not hear everything right, just as we as humans do not

✎ **TO-DO**: - ..it would speak as an advantage for bots if they can determine these things automatically..
- currently most tasks revolve around performing tasks like setting an alarm,
- answer suggestions functionality in chatbot equivalent - next step is to get around the user's frustration by making the bot at least more human.
- Alexa Skill will work in Germany in english and german -¿ add english after german

6.1 Frameworks and Data Structures

Node.js

Out of the languages supported by ASK and Lambda, we decide to use Node.js, a JavaScript (ECMAScript 6) framework due to its event-driven nature and to take advantage of its non-blocking I/O model. Being single-threaded, Node.js guarantees high performance at large scale with large volumes of requests considered. With its JavaScript (ECMAScript) foundation, no wonder it is becoming a standard in web-apps. Hence, the decision also comes due to the richness of develpers' experience with the implementation for Alexa Skills.

Apache Solr

w lucene w tika w nutch wel habal da if required

using state of the art standards in TF/IDF for seach queries

-Vorgehensweise: XML/JSON //- index über Lucene //- SolR Knoten...based on sth like when i say "am 10. august' it gets me masalan events..aha august ist ein monat, monat relates to calendar, calendar relates to events

Alternatives

Setup in Java using Maven [1]

```
<dependency>
<groupId>com.amazon.alexa</groupId>
<artifactId>ask-sdk</artifactId>
<version>2.0.2</version>
</dependency>
```

Additional APIs

> ✍ **TO-DO**: - Sayspring: helps developers prototype and build the voice interfaces for their Amazon Alexa and Google Assistant apps.
>
> - swagger
>
> - Flask
>
> -oauth for acct liking https://developer.amazon.com/docs/custom-skills/speech-synthesis-markup-language-ssml-reference.html
> - mp3 encoding ffmpeg -i ¡input-file¿ -ac 2 -codec:a libmp3lame -b:a 48k -ar 16000 ¡output-file.mp3¿
> for ssml builder npm lib to avoid &amp etc `https://npm.runkit.com/ssml-builder`

answethepublic.com

---

[1] `https://github.com/alexa/alexa-skills-kit-sdk-for-java/wiki/Setting-Up-The-ASK-SDK`

```
    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.

- swagger for handling JSON requests?

- `https://github.com/alexa/alexa-skills-kit-sdk-for-nodejs`

Description of the Interaction

6.2 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

Error: There was a problem with your request: "werden?" in the sample utterance "TestIntent was soll aus dieser Skill werden?" is invalid. Sample utterances can consist of only unicode characters, spaces, periods for abbreviations, underscores, possessive apostrophes, and hyphens.

do not use "?"

6.3 Design Guidelines and Documentations

✍ **TO-DO**: list all guidelines and docus here
Memory (Session, Context)
Entity Resolution
Interaction Model

Chapter 7

Design Best Practices

> ✍ **TO-DO**: since this was too long it has to go into a chapter by itself. now it needs to be put in groups of 3 points
> then eventually add best practices at the end - note below
> Achtung baby: don't put this chapter behind implementation as we want to show the implentation of that "good design"

> ✍ **TO-DO**: It's important to understand that we are at the beginnings of VUI design, but are making progress, e.g. VUIs - should become seamless in an approach like this: - art of bot design
> - best practices

> ✍ **TO-DO**: `https://developer.amazon.com/designing-for-voice/` `what-alexa-says/` available here even though i wrote my own things!! `https://developer.amazon.com/designing-for-voice/` `design-process/` `https://developer.amazon.com/` `designing-for-voice/voice-design-checklist/`
> ⌈ this is intro paragraph for only skills. kammello 3ala el ba2i ba2a ⌋

Throughout the model building process, we come across various nuances and details that might look subtle from a programming point of view. However, they very much can enrich or completely spoil the user experience, resulting in the users not returning to use our Skill again and can be an acceleration towards 1-Star reviews.

Based on our own exploration and through a growing voice design guide offered to Alexa developers [1] as well as personal recommendation from Alexa evangelist Memo Döring [25], we share a few good practices to consider before starting and throughout the development process. These are concerned partly with building the interaction model, as well as with the fulfilment back-end. Many of them also apply to voice assistants other than Alexa

---

[1] `https://alexa.design/guide`

1. **Design before Implementation**
   Since the Skill code usually starts small, it might be tempting to just work in iterations, develop for one scenario and then think of what else is needed as we go. As with any complex piece of software, it is very important to have a clear focus on the sequence of our workflow. Design takes an important role in this since it is the base upon which we build our Skill. If we have a bad design, we will end up getting stuck during the implementation. Good voice design means writing down full conversation flows, sentence variations, highlighting order of words, eliminating unnecessary utterances that could result in overfitting, letting Alexa deal with the dialogue management instead of using too many utterances.

   In the code part, it might be useful to use routers, intercepts, or both. Routers can be thought of as 'super-handlers' that would route our words to an intent, no matter what we say in whichever order. They can be thought of as keyword-sensitive listeners. Intercepts can be thought of blocks as code that would perform before and/or after a certain router takes us to a certain intent.

   The initial checklist can grow quickly and immensely but can also become very theoretical. Therefore, it is for every developer to figure out how to move to the VUI paradigm step by step with regard to what is important to them.

2. **Natural Language Conversation**
   When we are prompting for values, they are in a canonical order for how words should be structured when we have multiple adjectives. For instance in English we would say:

$$the \; \overbrace{big}^{size} \cdot \underbrace{brown}_{colour} \; bear$$

   because saying "big" and "brown" in the reverse order would not make much sense. Similarly, there is the rule of place before time, which results in sentences like:

$$\overbrace{every \; Saturday}^{time} \cdot I \; go \; to \cdot \underbrace{univerysity}_{place} \cdot \quad or \quad I \; go \; to \; \underbrace{univerysity}_{place} \cdot \overbrace{every \; Saturday}^{time}$$

   Many other examples are not actual rules, but more de facto in the language, so we would use them because of our linguistic logic justifies it as a right pattern, which eventually make us speak a language. There are many rules regarding shapes, abstract concepts. When we build programmatically, it is possible to get lost in the order of words in a sentence or even in the order of sentences.

Of course since this changes in every language, it is important not to take one language model and just fit it into another language, since there is much more that goes into that. For instance, it would not be very common to take a 'en-US' language model and fit it into a French one, where the temperature scales or other units are made for another locale.

3. **Question wording**
There is nothing more important a Skill can do, than asking the right questions. This does not only concern the formulation of the question, but also the purpose of the question. E.g. it would not be necessary to get a user's geolocation, if they ask for the weather, since the postal code is enough information to take from them as weather would not change dramatically within a district or an area. Collecting GPS coordinates from an Echo Device for instance is not an option, since these are not equipped with one. So, if we need approximate location, asking for precise location is bad practice.

Further, asking for long numbers, such as Model / Serial numbers is not good either, since the user will very rarely get that right. A Skill for tracking packages, where the user needs to spell out the tracking number is likely to fail and the user might just go and track it in a browser. This translates immediately into a loss since they will no longer use the Skill. We need to make speech happen without pauses so that the system understands it as one sentence altogether. Given that there is a lot more happening under the hood than transcription, Alexa works better with words and sentences than one-off numbers and letters.

4. **Context is King**
Alexa provides many tools for handling context, such as session attributes. This makes invoking a Skill for the first time be handled differently than the second time the same Skill is invoked. For instance if we say:

> *"I want to bake a cake"*

Alexa should respond with something like

> *"Okay, you need {ingredient1}, {ingredient2}, ..."*

then when we get back to Alexa an hour later, it should retain the context from last time to continue asking after invocation something like

> *"Did you get the ingredients?"*

and proceed to the recipe only once the user answers with a

> *"yes"*

and not restart the Skill from the beginning. In the meantime, we are not listening to the user. Just as it is embarrassing to a person to forget someone's name right after they meet them, not retaining the context of when the user was last seen using the Skill can make it sound dull and a bad way to communicate since it gives the impression of not being reliable. A user could think if Alexa cannot retain the simplest information, they would not trust doing more complicated things with it.

Maintaining context is important between sessions is just as important as across multiple sessions. For instance, greeting the user the first few times, should not sound like the same greeting after a month of daily usage. The user does not want to know every time how to use the skill for instance. Removing an extended greeting message saves the user time.

Moreover, retaining session should also be considered within an intent, such that if we say

> *"Did Tom Hanks win the Oscars this year?"*

> *"No."*

and then follow with a question asking

> *"What about Katja Benrath?"*

Alexa should still understand that we are asking within the `'OscarsIntent'` and differentiate between an `'actor'` slot and a `'director'` slot to match it within the same intent to the right query response. This is only doable by retaining context.

5. **Localisation**
Before we avail our skill to another country, it is important to check that the other country does not already have its own skill before we do double the amount of work. And as discussed above, things like linguistic and local changes beyond the classical imperial/metric systems (e.g. shoe sizes) could come into account.

6. **Asking for permission**
As mentioned above about taking the least necessary information to give the user the right answer, we want to manage a good balance on the trade-off between security on usability. If we ask the user to make complicated passwords and use tokens etc, no one will use our software. If we make the software too easily accessible, we might jeopardise its success for security problems. Same applies to the downside between functionality to levering specificity. As we do not want Alexa to spill a secret, we would not want to have someone in the room walking accidentally past hearing Alexa say how much money is in our bank account.

So Alexa should not in that case start the Skill with your account balance in the greeting message. We also do not want our neighbour next door be able to unlock our car with a generic command or one they may overhear.

7. **One Breath**

   If we cannot speak out a sentence Alexa can say in one breath, it is too long and should be broken down. Same goes for what Alexa would expect as input. So we should speak out a list in one go, but instead list up to three items and prompt the use to ask for more if they want. Context in that respect is also important. If our Skill wants to list public offices nearby, it does not make sense sometimes to mention the office if it is not open by the time we would get there for instance. That's why APIs have to be studied well before they are just linked to a Skill unlike the case with GUI where the user can scroll

   Opposite to the GUI paradigm, more is not necessarily better.

8. **Relevance and Repetition**

   We want the user to know with subtle hints that we are talking in the Skill about the same thing without repeating our text over and over. Implicit confirmations are good practices sometimes and bad at other times depending on the time and the focus we need to give out to hear a certain sentence. For instance for a purchase, we want to hear it in a full sentence. For just a slot confirmation for instance it may be better to repeat it in the next sentence.

   Example:

   > *"What time does today's Lufthansa flight arrive from Cairo?"*

   > *"LH 583 arrives to Cairo today at 7:40 PM "*

   and not just

   > *"7:40 PM"*

   This allows us without unnecessary back and forth confirmations to make sure that Alexa understood us right, since if she got a wrong airport code for **Cairns (CNS)** instead of **Cairo (CAI)** her answer would be:

   > *"LH 779 arrives to Cairns via Singapore today at 5:40 AM "*

   This avoids a scenario, where Alexa would sound cumbersome by asking

   > *"Did you just ask about flights from Cairo?"*

   or even worse

" Are you sure you want to check flights from Cairo today?"

If we want to add session retention to this scenario to make it more relevant, Alexa could also check next time we open the skill if we want to book the flight we just checked since it is likely to be still in our interest.

As for repetition, it makes more sense to remove repeating words that the user has to say and the sentences Alexa says. This can be done by changing boilerplate strings in the code to arrays where it becomes less predictable what Alexa would say next time we open the skill.

Here is a code example from our implementation:

```
GREETING_TEXT: [
'Ich kann dir mit den zahlreichen
 → Dienstleistungen der Stadt Berlin helfen! ',
'Möchtest Du dich über Öffnungszeiten oder eine
 → Dienstleistung informieren?',
'Willkommen in dem Hauptstadtportal. Was kann ich
 → für dich tun?'
]
```

```
//choose one Utterance for Alexa to respond with.
exports.getRandomResponseUtterance =
 → function(inputArray) {
const randomUtterance =  Math.floor(Math.random()
 → * inputArray.length);
return inputArray[randomUtterance];
}
```

To make it even more situation-dependent, think of a Skill for instance that would add to its greeting on friday a

" Have a nice weekend."

or if the user was not on the Skill lately, Alexa can present what the Skill can do since his/her last visit

9. **The Opposite of GUI**
Whenever we think of wanting to teach the user to stick to something, we should try to eliminate the thought. With a GUI, it is important to keep the interface consistent. A prevalent example is when Microsoft changed its Office Layout and it was hard to re-teach the users to the new layout, icons and ribbons view. In GUI it is usually preferred to avoid this consistence since it breaks the monotony and the repetition problem mentioned above.

10. **Speech Synthesis Markup Language (SSML) and Other Effects**
    SSML is a great industry-standard tool to make sound variations and add human-like effects to the conversation and are encouraged. Although not all tags are supported by all systems, Alexa offers an broad range of sounds.

    We should hence not exclude use of audio clips etc, music, music and speech together. Alexa also integrates Speechcons. These are certain words or phrases pronounced by Alexa more expressively. Here is an example of how these look different to a string:

```
<speak>
Sometimes when I think of all those best
 → practices, I just say,
<say-as interpret-as="interjection"> Horray.
 → </say-as>
</speak>
```

Speechcons are available in German [2] and English [3]

Also, Polly can change the sound of the character behind Alexa, which is commonly used in games with multiple users.

Timeline markers are a helpful feature with lists as well, e.g. when saying

" First, ...", "Second", "At the end"

11. **Flavours, Pointers, Acknowledgement of Feedback**
    Giving the user a feeling that they are not talking to a rigid machine, or even adding more 'manners' to the language, like when we want to ask Alexa to buy some clothes for us, she would sound better if she says

" Sure, what size?"

rather than just

" What size?"

Adding pointers like 'this', 'that', 'your', ... personalise the experience and wrap up the sentence more elegantly. Additionally, adding transitions like

*" **Now, we're going to talk about** ..."*

---

[2]https://developer.amazon.com/docs/custom-skills/
speechcon-reference-interjections-english-us.html
[3]https://developer.amazon.com/docs/custom-skills/
speechcon-reference-interjections-german.html

12. **Building flexible Paths**
   Also known as the graph- vs. frame-based design problem, since we have no idea what the user will say and cannot limit their choices through certain buttons on a screen etc, we want to be as captive as we can to what they say. For instance, a good Alexa Skill should be able to handle when the user says

   "I want {blue} {Nike} {Hi-Tops} "

   and also when they say

   "What are the trendy sneakers in stores"

   Also considering that the user could get too familiar with the Skill and use even more complex thinking with it, they might in the middle want to restart the search process for the perfect product. The Skill should therefore be flexible enough to cope with that. This translates into a more horizontal design as opposed to just following a workflow where the user will be asked only about a colour then a size then an item before they get to their product. Used in many advanced interactive voice response (IVR), there is also extensive documentation on this design field that goes beyond the scope of this thesis.

13. Voice-First, Voice-First, Voice-First, Multi-Modal

   Although there is enough emphasis to the voice-first approach throughout this work, it is also important to take advantage of using a screen whenever **necessary**, not whenever **possible**. Making a screen a supplement that the user does not have to depend on is vital to the user experience, since we need to go from the worst case of a lazy or even almost paralysed user who would not immediately jump to a TV screen when they are asked to do so by Alexa. The cards presented on screen should only reinforce what we say and not diverge at any time or provide important information that is not present in voice. This is as much GUI as we want to integrate in our VUI using Alexa and might change in a different context for niched markets with special cases for Alexa or other voice assistants.

14. **Modularizing the Skills**
   It is sometimes better to build small Skills each performing a single action and connect them together with the same APIs rather than building one gigantic skill that expects too many utterances that could render it futile. One example is to make a Pizza menu Skill and another Pizza order Skill that depends on the data from the Pizza menu app. Each would have a separate `LaunchIntent` enforcing a separation of concerns.

15. **Invocation Name**

    While Alexa's presence in Germany is fairly recent giving a freer choice of names, it is pivotal to the Skill that it has a name users can remember easily. The key is not just in selecting the key, but also testing what Alexa interprets it for. A Skill name like 'four miles' can be mistranscribed as 'for my's' or 'form isles'. Checking the speech history in the Alexa App (for the end-user) helps determine if these mistranscriptions happen too often.

16. **Designing for Natural Conversation**
    By having other users test the Skill conversation throughout the development process, many unnecessary scenarios can be circumvented and new ones unveil. The way we speak are blueprints of our verbal biases, as the way we use certain vocabulary is related to where we live, our own ideology or character, and who were interact with. We are used to only our own language or way conversation. As flexible as this can be, learning from others' missed intents can be helpful at all times. For instance, if we design a Skill to say a first name, someone might make the Skill say 'Günther' or 'Jacks' while someone else could make it say 'Mama' or 'Daddy', which are not in the predefined slot list `AMAZON\_DE.FirstName` (we discuss lists thoroughly in Chapter 8). Checking when and how a Skill fails is of great value to enhancing it.

17. Keeping it Simple

    A Skill that uses 1000 intents is more likely to break. If we can break these down into more modular intents, we avoid the risk. Same goes for utterances. While it is possible to make a lot of these, it is most of the time better practice to make use of dialogue management and entity resolution and reduces false negatives.

18. Allowing Surprises
    Even when the user says words that do not match to an intent, although we do not want to handle that, we should still be able to respond with an answer that is equally random to the user as they are random to Alexa. E.g. if we launch a Skill checking for flights and we ask it to order pizza, we can still educate the user about a new thing they were not expected to hear or give them a joke. Since the user was expecting to challenge or break the Skill, they would get surprised if they end up learning about something new or have a laugh instead.

Chapter 8

Skill Implementation

8.1 Setup

> ✍ **TO-DO**: codechunks different labeling??

step by step code analysis
```
https://github.com/alexa/alexa-skills-kit-sdk-for-nodejs/
blob/master/Readme.md
```

8.1.1 requirements

for audio

json format https://stackoverflow.com/questions/41776014/how-to-correctly-specify-ssml-in-an-alexa-skill-lambda-function

HTTP(S) endpoint: `http://newsreel-edu.aot.tu-berlin.de/solr/#/d115`

references:
```
https://developer.amazon.com/docs/custom-skills/
speech-synthesis-markup-language-ssml-reference.html#
audio
```

blogs: `https://developer.amazon.com/post/Tx3FXYSTHS579WO/Announcing-New-Alexa-Skills-Kit-ASK-Features-SSML-Audio-Tags-and-Devel`

With the JSON we have, we try to maximise its use, but we need to consider that with starting a Skill, it is better to start from scratch sometimes and as we go, we see what is the relevant information that we can integrate into our Skill.

We analyze the output of Virtueller Bürgerassistent and realize it makes less sense to start with that, so we refer to the underlying endpoint. Since this is the Solr Server that delivers JSON objects and is more realistic to maneuver, we analyse the queries we can get from there. and try to fit it into our interaction model.

Then we move on to the interaction model. On paper, we draft the use-cases to determine what are our intents first to group these into fewer intents than the services we have. Given that there are many public services related to a similar case, we design our Skill to make it possible to group them into less intents. The advantage of this is that it allows us to at least have fewer 'ServiceIntents' than the ever growing number of services, which means that we want to also be able to track new services as they get inserted into the catalogue to be able to either map them to old intents by extending these, or to introduce new intents if this does not work.

> ✍ **TO-DO**: moved from intro
>
> our now more than ⌈ 4 ⌉ scenarios:
>
> - a general scenario of predefined categories related to any service **[HIER SCHON ERWÄHNEN?** ⌈ (prerequisites, costs, documents, ...) ⌉ **]**
>
> - special application on **Residence Registration** - "Anmeldung einer Wohnung"
>
> - special application on **Applying for a Residence Permit** - mutliple services related to "Aufenthaltstitel"
>
> - "car registration" - special application on **Car Registration"** - multiple services related to "Kraftfahrzeug (KFZ)"

> ✍ **TO-DO**: moved from AWS Microservices list
>
> We might as well use just our own, any other privately or cloud-based server solution to host our code and use it as an endpoint for our software, however choosing Lambda takes away the overhead of linking the front-end with the back-end of the Skill

8.2 step-by-step

start with interaction model then use builder then fulfill functions

steps to git commit deploy clone change in browser change offline

if u use a browser, remember to keep the session active otherwise your model might get lost in the POST

8.3 Code Analysis

from `https://github.com/alexa/alexa-skills-kit-sdk-for-nodejs/blob/master/Readme.md` The difference between :ask/listen and :tell/speak is

that after a :tell/speak action, the session is ended without waiting for the user to provide more input. We will compare the two ways using response or using responseBuilder to create the response object in next section.

jsons sent/received in appendix 10.1

problems with countrylist cote d'ivoir, südsee (british territories overseas, ...)

legal things like the EU-partner rule. eu rules override local bas u cant explain it to people 3ashan they have to be give the choice. el mawdou3 mo3aqqad but codified here `https://eur-lex.europa.eu/legal-content/EN/TXT/ ?uri=CELEX:02004L0038-20110616`

8.4   Deployment

8.5   Approval and Publishing

Continuous Skill Approval is the process of Amazon deciding whether each uploaded version / update is still fit for purpose, make the skill better or worse in conjunction with other skills on the Store

> ✎ TO-DO: mention that 3ashan homa store w keda fal mawdou3 lazem yekoun mo7kam w 7agat homa bey7ebouha and the reasons why things could get rejected according to their policy and some scenarios

8.6   Debugging / Troubleshooting

8.7   Documentation Updates

https://www.gitbook.com/join/tu-berlin/-LAZYgGmoeaEZGb8cYg2   https://tu-berlin.gitbook.io/alexa/

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

Solr has to be secure `https://docs.aws.amazon.com/AmazonS3/ latest/dev/WebsiteEndpoints.html#WebsiteRestEndpointDiff`

Hey:

do this set up as prerequisites first as a deployment script

- install aws cli - install ask cli - set up a profile on AWS - ask init etc.

https://docs.aws.amazon.com/cli/latest/userguide/cli-chap-getting-started.html

There is no AWS credential setup yet, do you want to continue the initialization?

https://developer.amazon.com/docs/smapi/quick-start-alexa-skills-kit-command-line-interface.html

Manage IAM roles (User, groups, rights, policies etc.)

all logs go onto cloudwatch including when the request is not right etc...can be helpful to know what users want, beyond testing

amazon does not disclose avaliable values for their slot types (lists), but they give you examples here

===

finally, we had to resolve to the information publicly available to tailor custom scenarios

=== once you upload the new lambda, the old one is gone, unless you version it like this: https://docs.aws.amazon.com/lambda/latest/dg/versioning-aliases.html

====

first i got screwed over with this Big nerd ranch then this happened: alexa-skill module - so don't use this tutorial, although very helpful for a beginner and makes you understand what happens under the hood, it has been abstracted in many other function and the logic is no longer the same. - which explains why no one starred it

https://github.com/matt-kruse/alexa-app

https://www.bignerdranch.com/blog/developing-alexa-skills-locally-with-nodejs-deploying-your-skill-to-staging/

> ✍ **TO-DO**: OnLaunch
> IntentHandler
> intent is triggered by utterence
> account verlinkungen etc

Prob with outdated tutorials

> ✍ **TO-DO**: eventually mention here:
> as we mentioned Amazon's strong take on constant changes, we will go over the workarounds and circumventions to retain a working version of the Skill we present, discuss the downside of adaptability to these changes ⌈ (constantly basastem nafsi 3ala 7aga gedida) ⌋

Chapter 9

Evaluation

9.1 Alexa in General

Experian of Alexa as a whole `https://www.experian.com/innovation/thought-leadership/amazon-echo-consumer-survey.jsp`

9.2 Metrics

> ✎ TO-DO: **talk about umfrage-design:**
> skalen, yes no, choosing between limited answers, etc.
> combining logic and validation, such that you would be asked about only one thing if you answered the other respectively. done in english and german for purpse: cater for different people living in berlin
> conjoint analyse
> a-b testing - see what users prefer then come to conclusion that dienstleistung is the most important
> we evaluate how people speak to alexa with sample sentences.
> ask questions like "Did u know berlin.de has a behindertenberechtigt" to educate the person at the same time

> ✎ TO-DO: what disturbs you most about alexa?
> would u try it again if the question fails?
> -thats why the retention rate is low

    -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
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

9.3 Results

mention git commits?
    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

9.4 Discussions

✍ **TO-DO**: you mentioned in intro (structure of this thesis) that you will discuss ML approaches like term weighting

✍ **TO-DO**: wienbot screenshots
alexa app caught what i said screenshots

alexa ask georgia if u cant install it, here is a video https://vimeo.com/216737044

while it may seem trivial at the start to set up, in den details steckt der teufel. from installing npm to ... and the flexibility of the system - so many options to choose from: swagger, dynamo,...
    - 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 bürgeramt beyektebo, welche Rechtsgrundlage ḱeine⸗ auffällige Probleme masalan zay Perso, PA, personalausweis, how to introduce ëxpert modeṧo that if u add

56

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

> ✍ **TO-DO**: mention that building with alexa allows entertainment through small talk and assures the integration of the skill in a widely used platform, but small talk gets you out of the skill in the pro/con section. it's not a con but it needs to be addressed. like meaning that u develop an app for iPhone is not enough guarantee that having an iPhone makes people only use ur app.

Chapter 10

Conclusion and Future Work

10.1 Summary

kurze sätze to Alexa 3ashan mateghlats

`http://www-personal.umich.edu/~cellis/heteronym.html` homophones, homographs moved from ch2 Underlying Grammar: since languages do not work with a unified grammar and word types (adjectives, adverbs) are not simply replaceable by one another. If a person say I a

from ch 2: And so, naturally, what distinguishes a good system from a better one is how fast it learns.

> ✎ **TO-DO**: That's why it's good that there is more than one giant taking care of this

kritikk that amazon is v haphazard. zB workshop

10.2 Conclusion

10.3 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)

We are going to build neurons so they can bridge together (Alexa Podcast 18) Otherwise they will forget Branches stop growing when they reach another branch Intelligenceaggreation - amplification We are voice-first approach (as said earlier: Inner voice) We do not know much about human brain /intelligence- -the point is not in

taking over but making Internet more powerful (Podcast) information will appear as you need it: Voice first not voice only - less time to look at screen.

    -matensash el evaluation beta3et el chatbot [1]

---

[1]This derives into a possible scenario where Alexa's AI becomes smarter then maybe in a few years the concept of Skills won't exist as a stand-alone any more and would be integrated into Alexa's own brain without the user knowing and it would just be a hit or miss kind of thing.

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Appendix

On Etymology of Product Names

Product naming is a branding problem which companies deal with differently. In the case of Apple, with exception of the 'Apple Watch' and on their consumer products line, they opt for a clever version using the letter 'i' in front of simple common words, like iBook, iPad, iPhone. though this naming convention originally arose from 'i' to stand for 'interactive' celebrating the early adoption of the internet on the Macintosh product line, it has turned into a naming breakthrough since it had two effects: 1) it gives the user of Apple software or hardware product a feeling of personalisation for the letter 'i' would make something sound as belonging to oneself, namely " 'I', as a person" as a prefix for the name of the object create the name of the product, and 2) it is a marketing strategy to associate all products and services carrying the prefix 'i' with Apple without the need to name the company's name. This applies to products and services that came to life even long after people's adoption of the internet and the widespread use of Apple products, like with iCloud as a web service. Another example is with professional software products like AutoCAD combining the company's name (AutoDesk) with the product's functionality (Computer Aided Design). Companies like Adobe clearly prefer to name their products and services with their brand's full name included, as the case with Adobe Photoshop, Adobe Flash (formely know as MacroMedia Flash). Similarly, as the youngest of them, Amazon adopts a combined approach by stating the full name of the company on its consumer line like with 'Amazon Prime', 'Amazon Alexa' and a mix between 'AWS' and 'Amazon' like with 'Amazon SageMaker', 'AWS Firewall Manager' etc. on its developer B2B line.

Difference Between Lex and Alexa Skills

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 ćhatbotśo 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 Mobile-Hub and Amazon CloudWatch and easy integration with many other services on the AWS platform including Amazon Cognito, and Amazon DynamoDB makes bot development effortless. [2]

deep learning:

There's an obvious problem with applying deep learning to language. It's that words are arbitrary symbols, and as such they are fundamentally different from imagery. https://www.technologyreview.com/s/602094/ais-language-problem/ . Two words can be similar in meaning while containing completely different letters, for instance; and the same word can mean various things in different contexts.

---

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

Documentation

AWS

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

Outtakes from a JSON query node

```
{
"d115Description": "Eine Fiktionsbescheinigung
→ wird ausgestellt, wenn über einen beantragten
→ Aufenthaltstitel noch nicht entschieden
→ werden kann, z. B. weil<br />\n<br />\n<ul
→ class=\"list\"><li>Unterlagen fehlen oder die
→ Ausländerakte nicht vorliegt,</li>
[...]
```

```
{"d115Synonym": ["Aufenthaltserlaubnis",
"Aufenthaltstitel","vorläufig",
"Visum","Fiktionsbescheinigung"
]
```

```
"d115InfoLaw": ["§ 81 Aufenthaltsgesetz – AufenthG
::: false ::: http://www.gesetze-im-internet.de/
aufenthg_2004/__81.html"],
```

```
"d115Prerequisites": [
"Persönliche Vorsprache ist erforderlich ::: false
→ ::: ",
"Rechtmäßiger Aufenthalt mit oder ohne
→ Aufenthaltstitel ::: Zum Zeitpunkt des
→ Antrags muss die Antragstellerin oder der
→ Antragsteller entweder<br />\n<br />\n<ul
→ class=\"list\"><li>einen gültigen Aufenthaltstitel
→ (Aufenthaltserlaubnis oder nationales Visum für
→ längerfristige Aufenthalte – Kategorie D – )
→ [...]",
"Antrag auf Aufenthaltstitel ::: Eine
→ Fiktionsbescheinigung wird nur dann ausgestellt,
→ wenn [...] ::: ",
"Hauptwohnsitz in Berlin ::: false ::: "
]
```

"d115Requirements": [
"Bisheriger Aufenthaltstitel ::: Soweit vorhanden,
→ ist der bisherige Aufenthaltstitel mitzubringen,
→ z.B. der elektronische Aufenthaltstitel (eAT). :::
→ ",
"Nachweis über den Hauptwohnsitz in Berlin :::
→ <ul class=\"list\">
Bescheinigung über
→ die Anmeldung der Wohnung (Meldebestätigung)
→ oder
Mietvertrag und
→ Einzugsbestätigung des Vermieters
Mehr
→ zum Thema im Abschnitt „Weiterführende
→ Informationen\ ::: ",
"Gültiger Pass oder Passersatz ::: Eine
→ Fiktionsbescheinigung gilt immer nur in Verbindung
→ mit einem gültigen Pass oder Passersatz. ::: "
]

"d115Fees": "Ab dem 01.09.2017:
\n<br
→ />\n<ul class=\"list\">
Für Erwachsene:
→ 13,00 Euro
Für Minderjährige:
→ 6,50 Euro
Gebührenfrei für<br
→ />\n<ul class=\"list\">
Türkische
→ Staatsangehörige
Asylberechtigte
Ausländer, die im Bundesgebiet die Rechtsstellung
→ ausländischer Flüchtlinge oder subsidiär
→ Schutzberechtigter genießen
Resettlement-
Flüchtlinge im Sinne von § 23 Abs. 4 S. 1
→ AufenthG
",

"d115ProcessTime": "Die Fiktionsbescheinigung wird
→ bei Vorsprache ausgestellt."

Figure 10.1: Request Body Syntax as of 26.04.2018

```json
{"version": "1.0",
 "session": {
  "new": true,
→"sessionId": "amzn1.echo-api.session.[unique-value]",
  "application": {
→  "applicationId": "amzn1.ask.skill.[unique-value]"},
  "attributes": {
   "key": "string value"},
  "user": {
   "userId": "amzn1.ask.account.[unique-value]",
   "accessToken": "Atza|AAAAAAA...",
   "permissions": {
   "consentToken": "ZZZZZZZ..."}}},
 "context": {
 "System": {
  "device": {
   "deviceId": "string",
   "supportedInterfaces": {
    "AudioPlayer": {}}},
  "application": {
→  "applicationId": "amzn1.ask.skill.[unique-value]"},
  "user": {
   "userId": "amzn1.ask.account.[unique-value]",
   "accessToken": "Atza|AAAAAAA...",
   "permissions": {
    "consentToken": "ZZZZZZZ..."}},
  "apiEndpoint": "https://api.amazonalexa.com",
  "apiAccessToken": "AxThk..."},
 "AudioPlayer": {
  "playerActivity": "PLAYING",
  "token": "audioplayer-token",
  "offsetInMilliseconds": 0}},
 "request": {}}
```

source: ASK DOCUMENTATION [3]

---

[3]https://developer.amazon.com/docs/custom-skills/
request-and-response-json-reference.html#request-body-syntax

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List of Abbreviations

ACID	Atomicity, Consistency, Isolation, Durability
AI	Artificial Intelligence
ARN	Amazon Resource Name
ASCII	American Standard Code for Information Interchange
ASK	Alexa Skills Kit
AVS	Alexa Voice Service
AWS	Amazon Web Serivces
B2B	business-to-business
B2C	business-to-consumer
CEO	Chief Executive Officer
CIA	Competitive Innovation Advantage
CLI	Command-Line Interface
CSS	Cascading Style Sheets
DCG	Discounted Cumulative Gain
GB	Gigabyte
GUI	Graphical User Interface
HCI	Human Capital Index
HTML	Hyper-Text Markup Language
IoT	Internet of Things
IVR	Interactive Voice Response
LeiKa	Leistungskatalog der öffentlichen Verwaltung (public administration service catalogue)
ML	Machine Learning
MVC	Model-View-Controller
MVP	Minimum Viable Product
NLP	Natural Language Processing
NLU	Natural Language Understanding
NPM	Node Package Manager
OSI	Online Services Index
ROI	Return on Investment
SSML	Speech Synthesis Markup Language
TF-IDF	Term Frequency - Inverted Document Frequency
TII	Telecommunication Infrastructure Index
UN	United Nations
VUI	Voice User Interface
appx	approximately
app	(Mobile or web) application
DevOps	Development and Operations
excl.	excluding
Inc.	incorporation

Glossary

Alexa	5.1
Alexa Skill	5.1
Alexa Skills Kit	5.2
Amazon Developer Console	5.2
Application ID	erklärung
Intent	3.5
Interaction Model	3.5, 6.1
Lambda, AWS Lambda Function	5.2
Lex, Amazon Lex	5.2
Node.js	6.1
Polly, Amazon Polly	5.2
Public Service	1.2
Slot	3.5
Skill ID	erklärung
Transcribe, Amazon Transcribe	5.2
Utterance	3.5
Web Service	e.g. AWS
Bot	Unless otherwise mentioned, a chatbot
Hitlist	erklärung
Voice-first	an always-on, intelligent piece of hardware, where the primary inte