

# Chapter 15

## Conclusions



**Abstract** We conclude the book with the analysis of why it is so hard to build an industrial-strength chatbot and what the main problems are which need to be solved. We summarize the techniques employed in this book, mention deployment at Oracle and a university course on chatbots.

In this book we outlined the main problems on the way to build solid industrial chatbots. We analyzed the reasons it is so hard to find a chatbot demo today for a nontrivial task or to observe an intelligent behavior of a chatbot. At the time of writing of this book, it is easy to see how a success in AI can boost the chatbot development on one hand, but it is hard to detect intelligence in those chatbots that are available to the public, on the other hand. As the chatbot design bottlenecks became transparent, we came up with the plan to tackle the identified problems one-by-one and drew the system architecture to solve these problems.

We proposed a pathway to build a chatbot that can be demoed to impress an audience with its intelligence. We made a claim that an industrial chatbot needs to integrate a number of specific components instead of just following a certain popular paradigm such as data-driven, intent recognition frames or a specific set of rules.

We backed up this claim by describing a number of chatbot components with specific function, starting from an advanced search engine with the focus on linguistic features (Chap. 5), encoding semantics via a logic program (Chap. 6) and longer complex queries (Chap. 7). We then proceeded to discourse-level analysis and applied it to cohesiveness (Chap. 10), dialogue management (Chap. 11), argumentation (Chap. 13) and chatbot answer anatomy (Chap. 14). Having presented a high-level view of chatbot components and architectures in Chap. 2, we also covered explainable AI for chatbots in Chap. 3, such topics as NL access to a database (Chap. 4), chatbot thesaurus in Chap. 8 and content management in Chap. 9. In each Chapter we provided a stand-alone evaluation of the particular component to prove that it is meaningful to integrate it into the end-to-end chatbot, whose overall performance is hard to formally verify.

Conversational platforms will drive the next big paradigm shift in how humans interact with machines. The burden of translating intent shifts from a user to a computer. The platform takes a question or command from the user and then

responds by executing some function, presenting some content or asking for an additional input. Over the next few years, conversational interfaces will become a primary design goal for user interaction and will be delivered in dedicated hardware, core OS features, platforms and applications.

According to [Gartner.com](https://www.gartner.com), conversational platforms have reached a tipping point in terms of understanding language and basic user intent, but they still fall short. The challenge that chatbots face is that users must communicate in a very structured way, and this is often a frustrating experience. A primary differentiator among conversational platforms will be the robustness of their conversational models and event models used to access, invoke and orchestrate third-party services to deliver complex outcomes. Creating systems that learn, adapt and attempt to perform autonomously will be a major area of competition between the technology builders over next few years. The ability to use AI to enhance decision-making, reinvent business models and ecosystems, and remake the customer experience will drive the payoff for digital initiatives through 2025.

AI techniques are evolving rapidly and the industry would need to fund skills, processes and tools to successfully exploit these techniques and build AI-enhanced systems. Investment areas can include data preparation, integration, algorithm and training methodology selection, as well as model creation. Multiple constituencies including data scientists, developers and business process owners will need to work together.

There is a well-known formula for developing an intelligent *Chatbot = SearchEngine + Dialogue Manager*. Although the first component is so well tuned nowadays that it is really hard to suggest a further improvement, the Dialogue Manager component is still in its infancy. In the research community, a deep learning approach to dialogue management attempts to simulate human intellectual activity, learns from available dialogues which are not always meaningful and produce something that even children with special needs try to avoid. On the other hand, major vendors of chatbot development platform offer tools for hard-coded dialogue management that require a lot of manual work and produce very brittle chatbots, which can hardly deviate from a set of hard-coded dialogue scenarios.

Discourse linguistics is here to take dialogue management to a totally new level. It studies how humans organize their thoughts in text. For example, an author introduces an entity  $E_1$  in the first sentence, then introduces its two attributes in the second sentence, outlines a relationship between these attributes in the third sentence, and claims the difference with another entity  $E_2$  in the fourth sentence. In this book, we oriented Discourse Analysis towards representing logic and communication flow which can be machine learned from text and embedded into the Dialogue Manager.

We discovered that if a chatbot user expresses her problem in a few sentences in the initial utterance, the chatbot can automatically build the dialogue flow from the Communicative Discourse Tree (Chap. 10) of this utterance, and no manual dialogue construction is required. By automated Dialogue Management, the chatbot relieves developers from routine work of designing of dialogue flow on one hand and makes chatbot response more adaptive, so that it does not get stuck when encounters a scenario which has not been coded by a chatbot developer.

A dozen of patents based on the material of this book have been filed by Oracle in the area of how Discourse Linguistics helps chatbot become more helpful and intelligent. The company hopes these inventions will become popular among the community of chatbot developers. It is expected to accelerate chatbot development and deployment process, as well as improves the user experience running into unusual cases. Relying on discourse analysis, the logic of conversation can be automatically learned and help the chatbot to select the next utterance. With discourse analysis, specifying explicit rules of the dialogue state machine becomes unnecessary in most cases for task-oriented dialogues. A number of inventions described in this book such as question vs transactional request recognition have been deployed into the Oracle Digital Assistant in 2018 (<https://cloud.oracle.com/digital-assistant>); other inventions still remain as research prototypes.

A preliminary version of this book served as a primary material for the Master's course on Intelligent Systems in National Research University Higher School of Economics, Department of AI and Data Science, Moscow, Russia. The students used this book in their hands-on projects on developing chatbot in such domains as entertainment, culinary, finance, transportation and others.